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SOME MARINE INSECTS OF THE PACIFIC COAST OF CANADA.*

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INTRODUCTION.

The present paper deals with the strictly inter-tidal, rock-dwelling insects found in the neighborhood of the Biological Station in Departure Bay, Nanaimo, Vancouver Island, during the summer of 1927. Collections made in the late summer at Vancouver, Prince Rupert, and Ucluelet on the West Coast of Vancouver Island, revealed many of the forms already known but no new ones. The species discussed may therefore be regarded as representative of the whole coast, although further investigations are sure to prove the list incomplete.

In determining what are strictly inter-tidal insects two main factors have been considered: firstly locality, the early stages occurring at sufficiently low levels to be covered by every normal high tide; and secondly food, either living algæ or the bodies of living or dead animal life. Beach forms, whose larvæ can withstand inundation in sea water for a short time, are found plentifully in the decaying drift weed at high-water mark, or even in the dying filamentous algæ still attached to the rocks near high-water (e.g. *Tethina rostrata*), but these are clearly distinguished from the true inter-tidal forms by their saprophagous feeding habits.

On suitable shores, preferably where broken cliffs fall to the water or where large weed-covered rocks encumber the

* A study from the stations of the Biological Board of Canada.

beach, or even on isolated rocks and reefs completely covered at high-water, a remarkable scene of activity is witnessed at low tide in the spring and early summer. Diptera of many species are frantically engaged in completing their life functions before the return of the tide, and beetle larvæ and adults released from the dangers of marauding fish roam the rocks in search of food. The following inter-tidal insects were collected and studied in all stages: Diptera, Chironomidæ, *Camptocladius* three spp. nov., and *Paraclunio alaskensis* (Coq.); Tipulidæ, *Dicranomyia signipennis* Coq.; Dolichopodidæ, *Aphrosylus praedator* Wheeler; Coleoptera, Staphylinidæ, *Liparocephalus brevipennis* Mäklin and *Diaulota densissima* Casey.

While the saprophytic shore forms were not sought for specifically a number came to the attention of the writer during the course of the work; these were all Diptera, namely: *Tethina rostrata* Hendel (Geomyzidæ), *Scatella stagnalis* Fallen (*Ephydridæ*), *Hilara* sp. (Empidæ), *Megaselida ursina* Malloch (Phoridæ), *Heteromyza glauca* Coq. (Helomyzidæ), and *Fucellia fucorum* Fallen (Anthomyidæ).

Diptera.

Chironomidæ.

Genus *Camptocladius*.

Two marine species of *Camptocladius* have been recorded heretofore, namely *C. thalassophilus* Goet. and *C.* (*Phaenocladius*) *rupicola* Kieff. In neither case were the early stages discovered, and the marine habitat was presumed from the habits of the adults. In addition to these, several other members of the *Orthocladius* group are discussed by Edwards in his recent review of marine Chironomids (1926).

In Departure Bay and the neighboring coast three species of *Camptocladius* were taken breeding in the algæ between tide levels, and interesting data have been obtained regarding their morphology and habits. At low tide males may be observed swarming or running over the rocks in search of females, for emergence, mating, and oviposition must all be accomplished in the brief period that the rocks are uncovered. To this end the eggs and sperms are developed during the pupal stage and the fly emerges fully matured. Oviposition has been observed frequently in one species, *C. clavicornis*.

The female seeks a suitable place on the algal matting or in rock crannies near algæ soon after copulation and deposits her entire batch of 95-135 eggs in a ball-like mass surrounded by a small quantity of gelatinous matrix, which swells upon contact with water.

The larvæ of all species live among the filamentous algæ, freely at first but later making loose, open-ended tubes. *C. marinus* is confined to higher tide levels, being found only among the bright green *Enteromorpha* sp. which clothes the rocks and boulders in patches a few feet below high-water mark. The other two species may be found at lower depths, even to the levels uncovered only by the lowest tides in June, but here they are scarce as the type of alga changes largely to a lime-encrusted red alga unfit for food. The food consists of various kinds of filamentous algæ with a plentiful admixture of diatoms and spores.

The three species are most readily distinguished in the males, the females being very much alike. The larvæ and pupæ present certain characters by which they may be separated without undue difficulty.

Specific Description.

Camptocladius pacificus sp. nov.

Male.—Length of body 2.2 mm. Color uniform dull black throughout; appendages dusky; wings milky white with yellowish base; halteres pale, with dusky tip to knob. Eyes hairy. Antennæ (Text-Fig. 1, E, F) 1 + 13, slender, with macrochætæ more than half length of antenna; first three flagellar segments sub-globular, remainder becoming increasingly elongate and slender; terminal segment somewhat swollen, equal in length to 2½ preceding segments; hyaline sensory hairs long, fine, one pair on each segment except first flagellar. Palps (Text-Fig. 1, C) with four distinct segments and an imperfect basal segment; comparative lengths 5 : 9 : 14 : 19 : 25; no sensoria, numerous short setæ. Wings 1.3 × 0.6 mm., with typical venation (Text-Fig. 1, B); membrane devoid of microchætæ, posterior fringe alternating long and short hairs. Tibial comb on hind legs, spurs on all. Empodia narrow, hairy. Hypopygium (Text-Fig. 1, H) small, with long dorsal point hairy, chitinised; side-pieces short, broad at base, narrow at articulation of claspers, with rounded membranous cushion-like inner process; claspers narrow, slightly broader near base, pubescent, with stout chitinous peg on inner distal surface.

Female.—Length of body 1.8-2.1 mm. Color as in male but somewhat more shining. Antennæ (Text-Fig. 1, G) short, slender, with scape and five flagellar segments; first flagellar segment three times as

long as greatest width, constricted feebly in middle; succeeding segments cylindrical, only slightly tapering at either end; hyaline sensory hairs very slender, short; chaetæ scarcely longer than their segments except on fourth flagellar segment. Palps (Text-Fig. 1, D) 5-segmented, first imperfect, others with pronounced basal and terminal constrictions; comparative lengths 5 : 8 : 14 : 14 : 20; chaetæ few, short; sensoria absent. Wings 1.7 × 0.65 mm. (Text-Fig. 1, A). Tibial combs on hind legs as in male; claws pointed, empodia narrow, hairy. Spermathecæ two, elongate elliptical, 0.09 × 0.05 mm., dusky to base (Text-Fig. 1, I). Cerci short, rounded, without dorsal knob or projection.

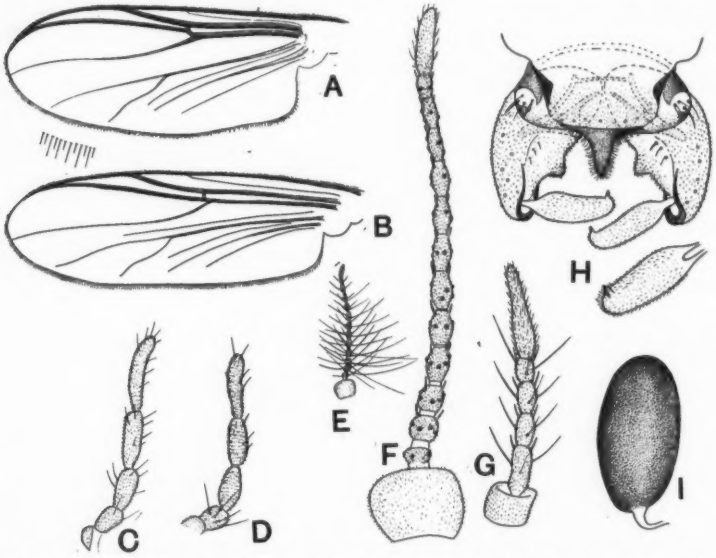

Fig. 1. *Camptocladius pacificus*. A, ♀ wing; B, ♂ wing; C, ♂ palp; D, ♀ palp; E, ♂ antenna with plumes; F, ♂ antenna; G, ♀ antenna; H, ♂ hypopygium; I, ♀ spermatheca.

Pupa.—Length about 2.3 mm. Color as in larva at first, deepening to black before emergence; exuvia faintly yellowish brown on thorax. Head pointed in profile (Text-Fig. 2, M), the point dusky. Prothoracic respiratory horns absent. Dorsum of each abdominal segment finely shagreened leaving two pairs of elongate clear spots, the anterior pointing obliquely inward, the posterior closer together and pointing obliquely outward toward the anterior pair; a multiple row of larger hooklets on posterior margin. Genital segment (Text-Fig. 2, J, K.) with flat covering plate nearly square but slightly narrower basally, bearing two minute points at posterior truncated corners. Male genitalia contained in conical processes only slightly exposed, shallow (Text-Fig. 2, L).

Larva.—Length about 5.5 mm. when full-grown (Text-Fig. 2, A). Color dull yellowish or olivaceous, mottled with dark green or indigo on middle segments; thoracic segments with or without subcutaneous pigmentation. Head brown to black around mouth-parts; small double eye spot. Antennæ (Text-Fig. 2, B) very small and short, situated on front of head capsule above mandibles; first segment scarcely longer than wide, its distal membrane bearing a 4-segmented flagellum equal in length to width of basal segment and a single Lauterborn's organ slightly shorter than the flagellum. Mouth-parts normal; labrum (Text-Fig. 2, D) with two prominent upper sensory processes on distal membranous area flanked and interspersed with lesser ones, and a lower

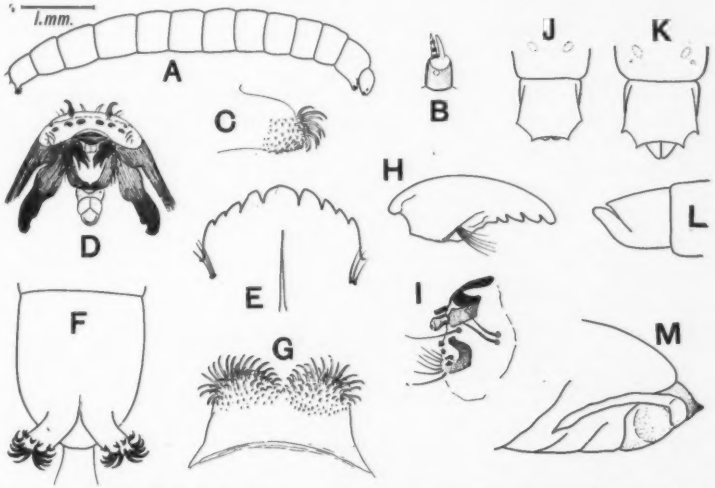

Fig. 2. *Camptocladius pacificus.* A, larva, entire; B, antenna; C, prothoracic pseudopod, lateral view; D, labrum; E, labium; F, extremity of abdomen, ventral view for anal pseudopods; G, prothoracic pseudopod, ventral view; H, mandible; I, maxilla; J, extremity of ♀ pupa; K, extremity of ♂ pupa; L, extremity of ♂ pupa, lateral view; M, head of pupa, lateral view.

row of six hooked processes; premandibles well developed, with broad base and flattened blade curving into two large rounded teeth, blade only pigmented. Mandibles (Text-Fig. 2, H) strong, with five distinct teeth; inner basal tuft of setæ about six, simple. Maxillæ (Text-Fig. 2, I) two-lobed, with very short palp on dorsal lobe, small sensoria and tuft of chaetæ on ventral lobe. Labium (Text-Fig. 2, E) with broad median tooth flanked by four smaller pointed teeth, first pair of which project almost as far forward as median tooth; lateral basal hairs about three in tuft on either side. Prothoracic pseudopod distinctly but not deeply bilobed (Text-Fig. 2, C, G) reaching forward to half length

of head, crowned with minute hooks which increase in size distally to moderately long slender hooks. Anal pseudopods (Text-Fig. 2, F) widely separated, short, furnished with five small and ten large curving hooks. Anal blood-gills absent. Body devoid of setæ; two tufts of three fine hairs without papillæ at tip of abdomen and a single very fine pair.

Described from numerous specimens of all stages taken in Nanaimo district, B. C. Types in National Collection, Ottawa.

Camptocladius marinus sp. nov.

Male.—Length of body 2-2.3 mm. Color uniform dull black; appendages lighter, legs testaceous. Wings milky but not as white as in *C. pacificus* or *C. clavicornis*. Halteres pale yellowish. Genitalia with velvety appearance due to fine light pilosity. Eyes hairy. Antennæ (Text-Fig. 3, I, H) 1 + 12, slender; basal 3 segments of flagellum subspherical, others gradually becoming elongate and slender until twice as long as wide; terminal segment as long as 3 preceding, swollen, with greatest width in middle or distal third. Hyaline sensory hairs on first five flagellar segments and terminal; longest macrochaetæ less than half the length of antenna. Palps with four distinct segments and very small triangular basal segment (Text-Fig. 3, L); comparative lengths 5 : 13 : 24 : 20 : 29; many short setæ. Wings 1.5 × 0.5 mm., with typical venation; membrane devoid of microchaetæ, posterior fringe alternating long and short hairs. Tibial comb on hind legs only, spurs on all; empodium narrow, hairy; claws with obliquely truncated, serrate tips. Hypopygium (Text-Fig. 3, N) with dorsal hairy point soft, unchitinised; side-pieces long, slightly narrowed before end, with row of chaetæ on outer side; process on inner surface of side-pieces reduced to soft membranous cushion bearing very short setæ; claspers flattened, broad at base narrowing slightly at bluntly rounded tip, finely pilose all over (Text-Fig. 3, M).

Female.—Length of body 2-2.4 mm. Color as in male. Antennæ short, slender (Text-Fig. 3, J); first flagellar segment less than twice length of any of succeeding three; last equal to 2½ preceding segments; hyaline sensory hairs on all flagellar segments; macrochaetæ nearly twice length of segments. Palps 4-segmented with rudimentary basal as in male (Text-Fig. 3, K); comparative lengths 4 : 8 : 13 : 8 : 18. Wings 1.7 × 0.7 mm. Legs as in male; claws pointed. Spermathecæ two, 0.1 × 0.06 mm., with subspherical dusky bulb and conical unpigmented base (Text-Fig. 3, G). Cerci short, somewhat produced caudo-ventrally, with small dorsal blunt point.

Pupa.—Length about 2.2 mm. Color as in larva, becoming black before emergence; exuvia light yellowish brown on head and thorax, very faint on dorsum of abdomen. Head rounded in profile. Prothoracic respiratory horns absent. Dorsal cuticular ornamentation of abdomen not materially different from that of *C. pacificus*. Genital segment with broad rounded dorsal plate devoid of lateral points, completely covering cerci in female (Text-Fig. 3, E) but in male leaving

exposed large processes containing side-pieces and claspers of hypopygium (Text-Fig. 3, F).

Larva.—Length 4.3 mm. when full-grown. When not immersed in water surface of body has slight satiny sheen faintly irridescent in longitudinal stripes. Color dull yellowish in anterior and posterior three segments of body more or less mottled with indigo or dark green; middle segments dark green to indigo, mottled, with yellowish patches. Head light brown, dusky at mouth. Antennæ very small, similar in structure to those of *C. pacificus*. Mouth-parts normal; labrum

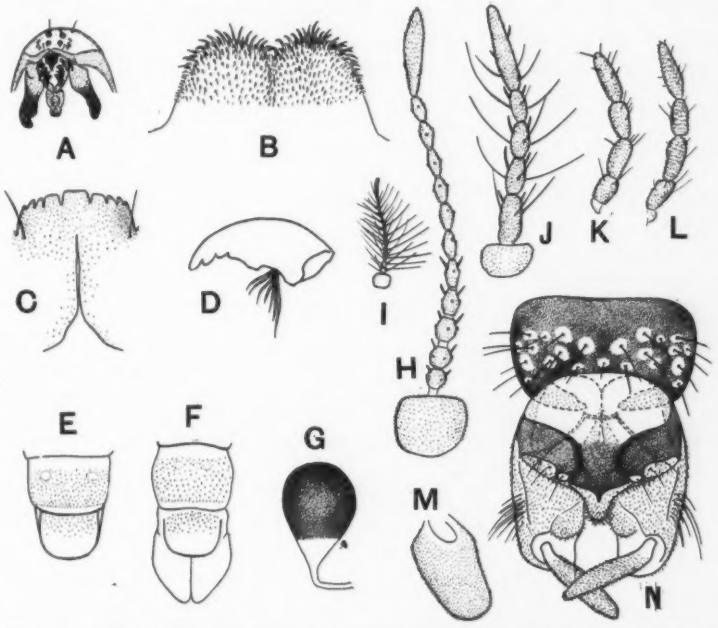

Fig. 3. *Camptocladius marinus*. A, larval labrum; B, prothoracic pseudopod; C, labium; D, mandible; E, extremity of ♀ pupa; F, extremity of ♂ pupa; G, ♀ spermatheca; H, ♂ antenna; I, ♂ antenna with plumes; J, ♀ antenna; K, ♀ palp; L, ♂ palp; M, clasper of ♂ hypopygium; N, ♂ hypopygium.

rounded, with numerous sensory hooklets and two papillated setæ on membranous area, two vertical rows of larger darker hooks on antero-ventral surface (Text-Fig. 3, A); premandibles curving forward into two rounded teeth. Mandibles short, curved, with four teeth on cutting edge (Text-Fig. 3, D), group of seven simple chaetæ on inner base. Maxillæ small, with large and small palps on upper lobe, group of few stout chaetæ and small sensory pegs on lower lobe; three stout chaetæ

on membranous area. Labium rather square-cut, (Text-Fig. 3, C) with broad median tooth and four to five lateral teeth reducing in size and becoming more pointed laterally. Prothoracic pseudopod short, imperfectly bilobed (Text-Fig. 3, B), bearing minute hooks which increase in size distally to larger, curved, light golden hooks, still small. Anal pseudopods short, widely separated, bearing about seven large and five small black hooks each. Body devoid of hairs except two tufts of three very fine setæ each without papillæ on last abdominal segment, and another very fine pair on same segment.

Described from many males taken swarming, few females bred from larvæ and pupæ, Departure Bay, B. C. June and July, 1927; also dancing males at Vancouver 8.IX.27 and Prince Rupert 11.IX.27.

Camptocladius clavicornis sp. nov.

Male.—Length of body 1.5-1.9 mm. Color uniform dull black throughout; appendages dusky. Wings milky white with base yellow. Halteres pale. Eyes hairy. Antennæ 1 + 8, short (Text-Fig. 4, I); 8th as long as preceding four segments together, swollen in basal half and tapering to tip. Flagellar segments 2, 3, 4, 5, 8 bearing a pair of curved hyaline sensory hairs; macrochaetæ only three to each segment except ultimate, very short. Palps (Text-Fig. 4, L) 4-segmented but first imperfect, rudimentary; comparative lengths 5 : 13 : 22 : 19; few chaetæ, no sensoria. Wings 1.4 × 0.45 mm., with typical undulating Cu_2; posterior fringe with alternating long and short hairs; membrane devoid of microchaetæ. Tibial comb on hind legs only, spurs on all; empodium narrow, hairy. Claws with narrow serrate tip. Hypopygium with prominent hairy dorsal point (Text-Fig. 4, O); side-pieces medium length, cyclindrical, with prominent knob on inner margin near extremity bearing fine short and longer hairs and blunt apical teeth; claspers flattened, slightly narrowed before distal extremity, fringed with short setæ (Text-Fig. 4, N).

Female.—Length of body 1.7 mm. Coloration as in male. Antennæ short, 1 + 5 (Text-Fig. 4, J); first flagellar segment twice as long as any of succeeding three, last three times as long as preceding, fusiform as in male but less swollen basally; all flagellar segments with pair of hyaline sensory hairs; only three short macrochaetæ on each segment except last. Palps 4-segmented, but first rudimentary (Text-Fig. 4, M); last segment longer and more slender than third; comparative lengths 5 : 12 : 18 : 29. Legs as in male, claws pointed. Spermathecæ two, elliptical, 0.07 × 0.05 mm., dusky almost down to neck (Text-Fig. 4, K). Cerci short, rounded, with blunt point on upper side.

Pupa.—Length about 2.0 mm. Coloration as in larva darkening before emergence; exuvia yellowish-brown on head and thorax, abdomen colorless. Head round in profile. Prothoracic respiratory horns lacking. Dorsal abdominal ornamentation practically identical with that of preceding species. Genital segment covered by rectangular

dorsal plate with two short sharp points on posterior lateral margins (Text-Fig. 4, E, F) (these may sometimes be seen as distinctly articulated chaetæ). Male genitalia enclosed in long, deep, conical processes (Text-Fig, 4. G),

Larva.—Length 5.0 mm. when full-grown. Smooth, shining; olive green or dull yellow mottled faintly with indigo at either end and strongly in first six abdominal segments. Head brown to black around mouth-parts and on posterior margin; eye-spot consisting of one large and one small contiguous pigment spot. Antennæ very small, similar

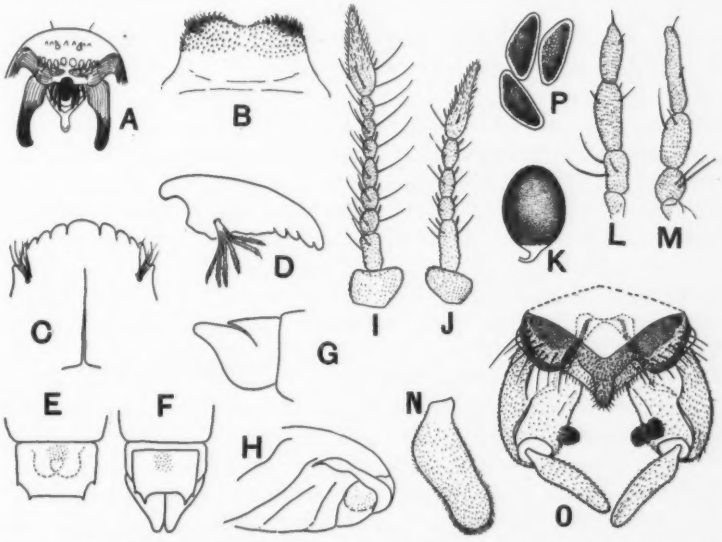

Fig. 4. *Camptocladius clavicornis*. A, larval labrum; B, prothoracic pseudopod; C, labium; D, mandible; E, extremity of ♀ pupa; F, extremity of ♂ pupa; G, extremity of ♂ pupa, lateral view; H, head of pupa; I, ♂ antenna, entire; J, ♀ antenna; K, ♀ spermatheca; L, ♀ palp; M, ♂ palp; N, clasper of ♂ hypopygium; O, ♂ hypopygium; P, eggs.

in structure to that of preceding species. Mouth-parts normal; labrum (Text-Fig. 4, A) with few apical sensory pegs and row of six subventral chitinous processes with serrate extremities; premandibles curving into two rounded teeth as in other species. Mandibles with about five bluntly rounded teeth (Text-Fig. 4, D); basal group of setæ finely setigerous. Maxillæ distinctly bilobed, with narrow-based palp bearing several sensoria on dorsal lobe, and tuft of setæ on ventral lobe. Labium with broadly rounded median tooth flanked by four or five smaller rounded teeth (Text-Fig. 4, C); lateral group of chaetæ five, subequal in size. Prothoracic pseudopod short, imperfectly bilobed, bearing many very small hooklets and tuft of slightly larger black hooklets on

antero-dorsal surface (Text-Fig. 4, B). Anal pseudopods short, widely separated, each bearing about eight large and four small black hooks. Anal segment with usual tufts of three fine setæ without tubercles, and a single pair of very small fine setæ.

Described from many specimens of all stages taken in Departure Bay, B. C., throughout the summer, 1927. Also at Ucluelet, at Vancouver, and at Prince Rupert in late summer.

Discussion.

Consideration of the species described above reveals a most interesting progressive degeneration from the normal members of the genus towards the extreme modification of the marine Chironomids of the subfamily Clunioninæ. *Camptocladius pacificus*, the most generalized, shows the male antennæ already reduced in the 13th flagellar segment from the long plumed process of such species as *aterrimus* and *stercorarius* to a slightly swollen segment equal in length only to 2½ the preceding segments, and in some cases this segment is fused partially or completely with 12 on one antenna or both. *C. marinus* has permanently fused 12 and 13 making a large swollen segment, while *C. clavicornis* has carried the reduction much further and exhibits only eight flagellar segments.

Accompanying this degeneration will be noticed a reduction of the plumes, *C. pacificus* being already much less plumose than normal members of the genus (Text-Fig. 1, E), and *C. marinus* slightly more reduced (Text-Fig. 3, I), while *C. clavicornis* has only three short chaetæ to each segment except the last (Text-Fig. 4, I). As might be expected, the two comparatively well-plumed species dance in little clouds over the rocks, not only in bright sunny weather but even in the heavy sea fog of early morning on the West Coast, while *C. clavicornis* never swarms and rarely flies, the males seeking their mates by running over the rocks and algæ in all directions. A further modification is evident as a corollary to this, as mentioned by Edwards (1926), namely the successive reduction in the size of the segment of the scape containing the "chordotonal organ." He regards the enlarged bristly palps of the submarine *Pontomyia* as possibly compensatory, but in *C. clavicornis* there is no such modification, in fact the reverse is the case for it will be seen that whereas *C. pacificus* and *C. marinus* have the normal number of segments *C. clavicornis* has one

less in the pulp; another reduction in the direction of the Clunionines. Although two of the species swarm copulation takes place on the ground, and it is noteworthy that no twisting of the male hypopygium has occurred, showing that such twisting is not necessary to terrestrial copulation.

The females show no marked adaptation to their special environment, or degeneration from the typical forms of the genus, in fact they present very few distinctive characters that may be used in separating the species.

The early stages differ from the fresh-water members of the genus in the usual respects, chiefly the absence of the anal blood-gills in the larva and of the pupal prothoracic respiratory horns. While the loss of these features is the rule among marine Nematocera it is by no means without exception, as may be shown in the pupal prothoracic horns of *Paraclunio alaskensis* and *Dicranomyia signipennis* in this paper and the anal blood-gills of a very small Chironomid larva found in marine algæ sent from Nanaimo in February, a species which evidently breeds only in winter and early spring and hence was missed in the summer's work. The modifications of these marine *Camptocladius* larvæ are not nearly so profound as in some terrestrial species of the genus (Malloch, 1917), nevertheless a progressive degeneration will be noted in the prothoracic pseudopod, the terminal hooklets or claws becoming successively smaller in the same order as was observed for the male antennæ. I can offer no explanation to account for this degeneration, since it would seem that well-furnished pseudopods are as useful and necessary among marine algæ as in fresh-water environments; moreover the modification is not carried further in other marine genera. Two other reductions occur here that are quite frequent among marine larvæ, namely the small size of the antennæ and the absence of setigerous tubercles on the anal segment. A tuft of three very fine setæ is all that remains of the normal papilla bearing about five long curving setæ.

Paraclunio alaskensis (Coquillett) 1900.

Undoubtedly this is the most conspicuous of the inter-tidal insects in the spring and early summer on the Pacific Coast of Canada. The long-legged males are in a constant state of activity on every rock and stone of their favorite beaches,

scampering about with ungainly agility in search of newly emerged females. They rarely take to flight unless molested. Pairs may be found in copulo everywhere, the male remaining in attendance during oviposition so that it is unusual to discover a female alone. The method of oviposition differs from that of most Chironomids, the eggs being deposited not in chains or masses but inserted singly in the filamentous algæ by means of the pointed valvular ovipositor. The nearest related genus of which any biological data are available, namely *Charadromyia* in the mountain streams of Hawaii, has eggs of similar form, but they are placed on end in a single layer on smooth rock surfaces (Terry, 1912).

Adults of *P. alaskensis* may be found at any inter-tidal level, but have never been seen to move up in front of the incoming tide and take shelter above high-water; all their life functions are completed during the space of one low tide, and every tide sees a fresh emergence as numerous as before. The larvæ occur most plentifully at the higher inter-tidal levels, from one foot to about eight feet below high-water mark (the maximum tidal difference in this region of the Coast is 13-14 feet). They may be found in almost any matted growth of filamentous algæ, some preference being shown for the vertical sides of large boulders and rocks. As the season advances and the sea water becomes warmer this algal matting gradually dies off until in August the rocks are left bare and clean. It is then difficult in sheltered inside waters to find sufficient algæ to harbor larvæ and still more difficult to find larvæ themselves, while emergence of adults is reduced to a minimum or ceases completely. In autumn the cooling waters permit the growth of the algæ again and the few surviving larvæ transform and emerge to provide another generation. Seaweed received from Departure Bay in the middle of February contained larvæ, and adults were reported showing that breeding continues to some extent even in winter. Indeed it is only thus that the population could increase sufficiently to produce the great numbers of adults emerging daily in the spring.

Specific Description of Early Stages.

Egg.—Size 0.4 × 0.2 mm. Ovoid, with conspicuous micropyle (Text-Fig. 6, C); chorion smooth, shining; color yellow when deposited, darkening to dull olive green before hatching.

Larva.—Length 9-11 mm. when full-grown. Color: head dark brown to black around mouth-parts and occiput. Eye-spot small, single-lobed. Body dull yellow to olivaceous, with a purplish or reddish cast in many instances; subcutaneous mottling of indigo feeble on thorax and first few segments of abdomen only. Female larvæ, and to lesser extent males, with light yellow area along sides of last three segments of abdomen caused by gonads developing within. Head tapering only very slightly towards mouth-parts giving a noticeably "square-cut"

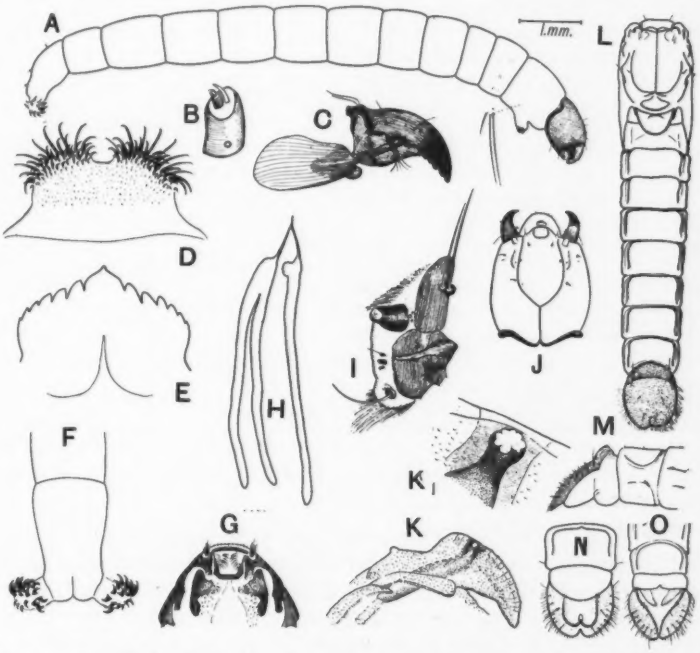

Fig. 5. *Paraclunio alaskensis.* A, larva, entire; B, antenna; C, mandible; D, prothoracic pseudopod; E, labium; F, extremity of abdomen for anal pseudopods; G, labrum; H, salivary glands; I, maxilla; J, head of larva; K, right prothoracic respiratory horn of pupa, outer view; K_1, end of trachea in respiratory horn; L, pupa, entire; M, extremity of pupa, lateral view; N, extremity of pupa, ♂, ventral view; O, extremity of ♀ pupa, ventral view.

appearance in dorsal view (Text-Fig. 5, J). Antennæ short (Text-Fig. 5, B); a stout basal segment with sensory pore, terminal segments reduced to two, very small; Lauterborn's organ single, as long as two distal antennal segments. Labrum bearing on underside two brush-like groups of short bristles and numerous medially-pointed spines (Text-Fig. 5, G); premandibles broad in side view with three rounded

teeth. Mandibles stout, heavily chitinised (Text-Fig. 5, C), with five large blunt teeth, an inner tuft of five simple chaetæ, and a large chitinous lamella for attachment of muscles joined by rod to surface of mandible. Maxillæ simple, with indistinct bilobed structure (Text-Fig. 5, I) ; a large conical palp on upper lobe, a simple spine on lower. Labium Text-Fig. 5, E) with large median pointed tooth (point frequently broken off) flanked by six smaller teeth on either side. Hypopharynx consisting of a stirrup of chitin receiving the salivary duct and an anterior membranous lobe bearing many sensory spines, hairs, and short processes. Prothoracic pseudopod bilobed but not deeply divided (Text-Fig. 5, D); crown of many black hooks on either lobe increasing in size from very small basal hooklets through stouter curving ones to slender slightly curved hooks on summit. Anal pseudopods short, widely separated, each bearing 19 hooks, small and large, in crown interrupted on posterior side (Text-Fig. 5, F). Anal blood-gills absent. Surface of body with very few microchaetæ on thorax; anal segment with three pairs of very fine setæ without papillæ. Salivary glands unequal (Text-Fig. 5, H), left divided into two equal, long, tubular glands, right single with rounded basal lobe (in some instances the double gland occurs on the right but never on both sides).

Pupa.—Length 5.5-8.0 mm. Color as in larva at first, darkening as adult within develops. Exuvia colorless except in few regions of dense yellowish chitin. Prothoracic horns wedge-shaped, point bending forward, downward, and slightly inward (Text-Fig. 5, K); composed of roughened chitin corrugated along upper margin. Trachea entering by long cylindrical felt chamber and opening externally by one multilobed, membrane-covered pore (Text-Fig. 5, K_1) one-quarter the length of upper margin from posterior extremity. Last abdominal segment obliquely truncate (Text-Fig. 5, L, M) forming an elliptical fringed disc of thick chitin; under surface with tapering, pointed case for genitalia in female (Text-Fig. 5, O), bilobed in male (Text-Fig. 5, N).

This characteristic abdominal termination is exhibited by pupæ of *Telmatogeton sancti-muli* (see Johannsen, 1905) and *Charadromyia* the Hawaiian Chironomid of mountain streams (Terry, 1912). The present species and *Charadromyia* both pupate in the silken tubes of the larvæ, and *T. sancti-pauli* in all probability has simlar habits, so the most plausible explanation is that the disc is used as a piston in the tube to force the pupa out to the surface when ready to emerge. Terry described it as "sucker-like," but in view of the habitat of the pupa and the structure of the organ no such function can be ascribed to it.

Discussion.

The adults were described by Coquillett (1900) but no figures were given then or subsequently, no mention was made of the early stages, nor was there any indication given that the

early stages were marine in habitat; hence the species was not discussed by Edwards in his recent review of Marine Chironomidæ (1926). Mr. Edwards has recently examined the type specimens of *Telmatogeton* and other Clunionines: he places *alaskensis* in the genus *Paraclunio* but does not make it conspecific with Kieffer's *trilobatus* as did Malloch (1915). Mr. Edwards discusses in a forthcoming paper ("Konowia") the systematic relationship of all Clunioninæ with trilobed tarsi, and the present author will content himself with pointing out the peculiarities of this strange species.

The first impression is of an ungainly, long-legged, soft-bodied fly, black, with dusky black wings. Upon capture the body is seen to be dark brown with a delicate sheen, and the head ludicrously small (Text-Fig. 6, B). The antennæ of both species are alike, a greater reduction in the male than is found in any Chironomidæ outside the Clunioninæ; the one-segmented maxillary palps are usual but not invariable in this group (Text-Fig. 6, E). Both sexes show a peculiar little pigment spot on the postgenæ down behind the compound eyes (Text-Fig. 6, B, *ps*). In appearance they resemble ocelli, but their unnatural position and their structure preclude such an explanation. Sections and "optical sections" reveal a poorly organized mass of pigment-filled cells with three distinct hyaline outer portions resembling primitive lenses. But the whole is subcutaneous, the hypodermis passing over it unbroken, and no nerve is discernible although the larval eye-spot, exceedingly primitive itself, has a very definite nerve. The organ therefore remains an enigma, peculiar apparently to this species.

In the male hypopygium two most striking differences are found from other related forms. The whole hypopygium is usually rotated to the left through an angle of 75-90 degrees (Text-Fig. 6, G, H), a condition almost unique among Diptera, where rotation if occurring at all is carried through 180 degrees (Culicidæ, Psychodidæ, some Tipulidæ, some Ceratopogoninæ). An occasional specimen is found with hypopygium normal or even twisted to the right, which would indicate that the twisting does not occur immediately upon emergence as in other Diptera but is the result of copulation. On the other hand a male specimen of *Charadromyia*, which in many respects is very similar to *Paraclunio*, revealed a distinctly asymmetrical 8th segment and the same twist of the hypopygium to the left.

The mating position is a modification of what Lamb (1922) calls "the male vertical pose," the male straddling the female on the ground with his abdomen usually to the right side of the female. The second unique structure is the protrusible anal tube on the "upper" side before the hypopygium (Text-

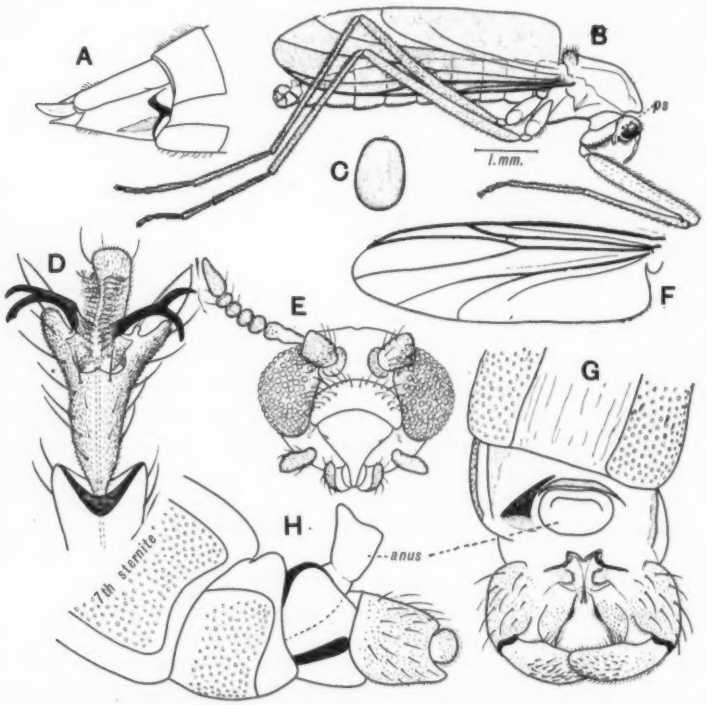

Fig. 6. *Paraclunio alaskensis*. A, extremity of ♀ abdomen; B, ♀ entire; *ps*, pigment spot; C, egg; D, last tarsal segment of ♂, ventral view; E, ♀ face and antenna; F, ♂ wing; G, ♂ hypopygium, ventral view; H, ♂ hypopygium, lateral view.

Fig. 6, G, H); this is not evident in pinned specimens where much shrivelling occurs but, is readily observed in every specimen preserved in alcohol. Such an organ seems unnecessary in an insect that only lives a few hours and has never been observed to feed, but possibly it is of some use at copulation. In dissecting to ascertain that this tube did actually constitute

the end of the intestine the rectum was found completely filled and distended with more than twenty rectal papillæ (rectal "glands") in place of the usual two of Chironomids, or four or six of most other Diptera; this was found constant in both sexes. Inasmuch as the environment and habits of the adults are not materially different from those of many other flies with the normal number the discovery does not appear to throw any light on the function of these much discussed organs.

A striking variation in size of the adults occurs during the summer, directly correlated with the increase of temperature and decrease in food supply. Adults taken in late summer were less numerous, and had diminished in size to less than half that of the early spring forms (3.2 mm. as against 6.6 mm. in length of thorax and abdomen of males). This diminution is unaccompanied by any morphological changes.

Tipulidæ.

Dicranomyia signipennis Coquillett 1905.

Early in May, 1927, my attention was arrested by large numbers of crane flies swarming around the rocks of the N. W. corner of Newcastle Island, Departure Bay, B. C.; they occurred literally in thousands, flying just above the surface of the sea in the evenings as the tide was falling. Upon capture only males were found and since it seemed improbable that land forms would come down to the sea to mate the obvious inference was that they must be breeding there, and the males were waiting for the females to emerge. It was during a careful search for the early stages on the rocks exposed at low tide that the marine insect fauna discussed in this paper was first revealed. Tipulid larvæ were finally discovered, not in the *Fucus* which caps every rock as was suspected from the place of swarming of the males, but in the close matting of filamentous algæ below, among barnacles, small mussels, and other marine animals.

The larvæ may be found in greatest numbers in the bright green *Enteromorpha* sp. coating rocks in sheets and patches a foot or two below high-water mark. Below this they occur in the matting of filamentous algæ down to seven feet below high water. This means that they are covered by sea-water daily for periods varying from one to six hours and more at certain

seasons. When a larva is immersed under laboratory conditions, a small bubble of air is retained on each side of the spiracular disc, and this must suffice for respiration during the period of immersion, being kept pure by its direct contact with the water. I have never observed a larva to make use of the many bubbles of oxygen produced by the photosynthetic activity of the algæ. Prolonged immersion invariably kills the larvæ unless the water is very shallow. Occasionally a larva may be found moving about on the surface of the algæ, but they normally remain in loose silken tubes constructed in the algæ, frequently deep in the crevices of the conglomerate rock or between barnacles. They feed on the vegetation that can be reached from the end of the tube, any fine algæ or diatomes being accepted. The intestinal tract is commonly infested with a Gregarine in large numbers.

The pupæ remain in the larval tube until ready to emerge when they wriggle out to the surface. Pupal exuvia may be picked off a suitable rock in great numbers at low tide.

The adults are most conspicuous when swarming on the dropping tide, but at low tide they may be found resting on the vertical or overhanging sides of rocks, flying from place to place, or ovipositing among the algæ. An occasional individual may be seen flying across the water at some distance from the shore. Copulation apparently occurs at emergence, hence the active swarming of the males, but at this time the eggs are not mature. At oviposition the male is again in attendance, and presumably there is a second copulation. The eggs are placed singly or in small groups in the algæ by a rapid motion of the whole body produced by flexion of the legs.

The winter is passed in the larval stage, adults being most numerous in May, at which time few larvæ remained. During June, July, and August adults became more and more scarce and larvæ more readily found. These larvæ live through to the spring, Dr. Clemens, Director of the Biological Station at Departure Bay, reporting no swarming adults during the winter.

The species has been found at various points around Departure Bay and at Vancouver but nowhere as numerous as on the N. W. corner of Newcastle Island as described above. At Ucluelet on the West Coast of Vancouver Island larvæ and pupæ were plentiful in late August but adults scarce. No specimens were found at Prince Rupert, which is perhaps

beyond their northern limit. Marine Tipulids are exceedingly rare; only one other species has been described, namely *Psiloconopa marina* Pierre (1924) from two pupæ taken between tides at Ambleteuse near Wimereux, Northern France. And Mr. F. W. Edwards tells me he collected one, not yet described, on the coast of Chile in 1927.

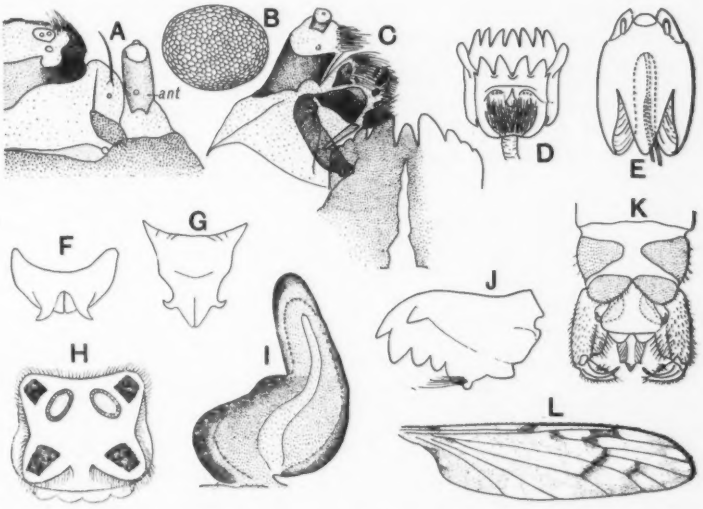

Fig. 7. *Dicranomyia signipennis*. A, right half of labrum, dorsal view, and antenna; B, egg; C, right maxilla and labium, ventral view; D, hypopharynx; E, larval head-capsule, dorsal view; F, last pupal segment, ♂; G, last pupal segment, ♀; H, spiracular disc of larva; I, pupal prothoracic respiratory horn, lateral view; J, mandible; K, ♂ hypopygium, ventral view; L, ♂ wing.

Specific Description of Early Stages.

Egg.—Size 0.4 × 0.33 mm.; subspherical; chorion smooth, finely reticulate (Text-Fig. 7, B), faintly brown; color orange yellow from larva within.

Larva.—Very young larvæ orange yellow, changing later to coloration varying from dull olive green to dark reddish brown, mottled. Color due entirely to blood, intestinal contents, and fat-body; pericardial nephrocytes always visible, bright green. Full-grown larva 12-15 mm. when fully extended, 1.3 mm. in diameter. Tapering slightly at anterior end, more abruptly at posterior extremity to small spiracular disc. Cuticle devoid of hairs or spines; toothed creeping ridges on dorsum of first abdominal segment, following six segments with both

dorsal and ventral creeping ridges, all on first annulus of segments. Spiracular disc small, quadrate (Text-Fig. 7, H), median dorsal lobe absent, remaining four equal sized, blunt; spiracles dark, elliptical, comparatively smaller than in other species of *Dicranomyia;* lateral and ventral lobes each with light brown quadrangular spot; short curved hairs fringing the whole. Anal blood-gills absent. Head capsule: antennæ short, consisting of single cylindrical segment with circular sensorium (Text-Fig. 7, A, *ant*), and small apical papilla. Labrum transverse, (Text-Fig. 7, A) with complete dorsal chitinous band; anterior margin slightly indented in middle, fringed with short hairs and longer tufts at sides, no sensory hairs. Two oval hyaline areas at sides each containing two small papillæ; behind these two much smaller circular sensoria. Mandibles broad, with four distinct teeth on ventral cutting edge, the second being largest (Text-Fig. 7, J); dorsal cutting edge with single sharp tooth on short, sharp ridge; a small prosthecal tuft of bristles. Maxillæ (Text-Fig. 7, C) with narrow strap-like cardo bearing two apical setæ; stipes small, triangular; outer lobe with cylindrical palp bearing one sensory peg, a dense brush of hairs on inner margin; inner lobe with numerous sensory pegs and dense fringe of hairs. Hypopharynx (Text-Fig. 7, D) normal for the group, with anterior row of seven teeth, two lateral teeth, and four larger teeth in posterior row flanked by a very small tooth on either side. Labial plate broad, almost divided in middle (Text-Fig. 7, C), median tooth shorter than those on either side; about seven teeth in all.

Pupa.—Length about 10 mm. Coloration as in larva, wing-pads and legs becoming darker as adult develops. Exuvia light brown on thorax, abdominal welts, and cauda. Prothoracic horns dark brown to black, with prominent dorsal lobe and finger-like extremity (Text-Fig. 7, I); inner surface "cushioned" with delicate membrane. Abdomen with four dorsal welts and two ventral; female cauda elongate, twice as long as wide, with slight swelling in middle and recurved hooks on each half of the split extremity (Text-Fig. 7, G); male cauda shorter than half its width, with two hooks as in female (Text-Fig. 7, F).

Adult.—The adults were described by Coquillett (1905) from one specimen of each sex taken at Eureka, Cal. The typical spotted wing with short subcosta is figured here (Text-Fig. 7, L) and the male hypopygium (Text-Fig. 7, K) to facilitate identification.

DOLICHOPODIDÆ

Aphrosylus praedator Wheeler 1897.

This species was described by W. M. Wheeler (1897) with two other species of the same genus (*grassator* and *direptor*) collected on the coast of California. He discovered two larvæ which he presumed to belong to the commonest species, *praedator*, but did not observe the pupæ. In the present paper figures are given (Text-Fig. 8) of the adult wing and antenna, the spiracular

disc of the larva, and the pupa in its cocoon, which will enable workers to identify the species. The antenna differs somewhat from Wheeler's figure, but the other characters agree so well that there can be no question to the identity of the species.

Aphrosylus is very numerous in Departure Bay and the vicinity during the spring and early summer, becoming scarcer in late summer in common with the rest of the marine insect fauna. The dull black adults with scarcely a trace of metallic

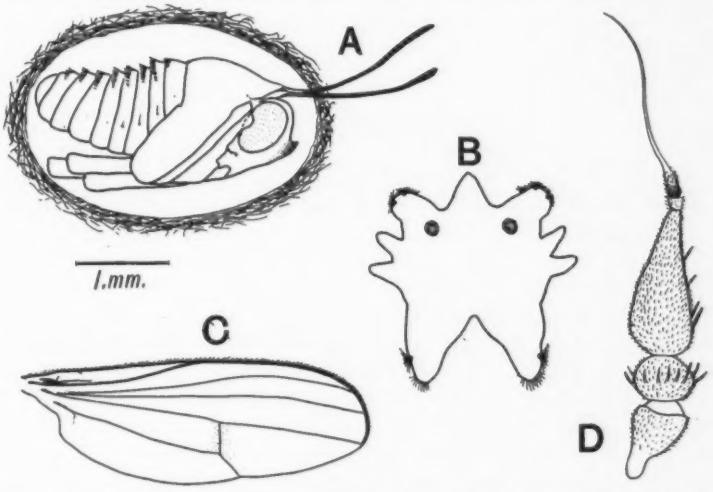

Fig. 8. *Aphrosylus praedator*. A, pupa in cocoon; B, spiracular disc of larva; C, wing; D, antenna.

sheen may be seen flying about or resting on the alga-covered rocks between tides on steep rocky shores. They are predaceous as indicated by their name, and feed upon both larvæ and adults of the marine *Camptocladius* spp. already discussed, probably on other small insects, and possibly on marine worms and small Crustacea found in the same habitat.

The larvæ are cylindrical, glistening white, with seven creeping ridges furnished with tranverse chitinous projections. The spiracular disc is very characteristic (Text-Fig. 8, B), differing from other Dolichopodid larvæ as pointed out by Wheeler in having two small lateral lobes between the usual large dorsal and larger ventral lobes. Like the adults the larvæ are predaceous, hence are found singly in the matting of filamentous algæ covering the rocks. No larvæ have ever

been found feeding and all forms of animal life were refused under laboratory conditions; the contents of the intestine are too amorphous to give any clue to the nature of the food supply, which therefore still remains unknown.

The pupæ are found in rounded, elliptical cocoons loosely spun in the filamentous algæ. The short stout pupa thrusts its long, black, strap-like prothoracic horns out through an opening in the cocoon to a distance equal to the length of the thorax (Text-Fig. 8, A). The head bears a short pointed tubercle on the face which is probably utilised at emergence when the pupa is working its way out to the surface. During early summer exuvia may be picked off the alga-covered rocks in large numbers at every low tide, but it is not so easy to find the pupæ hidden in their cocoons.

COLEOPTERA.

STAPHYLINIDÆ.

In addition to the foregoing Diptera two species of beetles were plentiful along the rocky weed-covered shores of Departure Bay and the vicinity. These proved to be *Liparocephalus brevipennis* Mäklin and *Diaulota densissima* Casey described in 1893 (Casey) and scarcely mentioned since. Figures of adults and their larvæ are furnished herewith to facilitate identification, for these are by no means the only inter-tidal beetles; others are recorded from various parts of the Pacific Coast but do not occur in the neighborhood of Nanaimo or are very rare. Casey describes another species of *Liparocephalus, cordicollis*, whose antennæ are distinctly longer than the head and thorax, whereas in *brevipennis* they are barely as long. Also the prothorax of *cordicollis* is "strongly transverse, very strongly constricted at base and not more than twice as long as the elytra." Another species, *Diaulota insolita*, is very close to *densissima* but may be separated by the prothorax "at its widest point fully as wide as the elytra." Casey's records are from Wrangel, Alaska, Queen Charlotte Islands, and Washinton State.

Both species possess short elytra, as may be seen in the figures (Text-Fig. 9, B, F), but there is no functional second pair of wings, so that the beetles are incapable of flight. Living as they do at all levels between tides they must inevitably be submerged daily for a varying length of time. In the laboratory beetles placed on the surface of sea-water in a dish containing submerged algæ will climb down through the surface film and

move about actively on the plants under water. There is a limit, however, to the length of time they can withstand submersion, even though they carry a film of air entangled in the hairs of the body, and in such experiments the beetles were always found on the surface after a period of three or four hours. They could be kept longer in a vessel containing moist algæ under conditions similar to those existing at low tide, but although attempts were made to secure pupation and oviposition these were never observed.

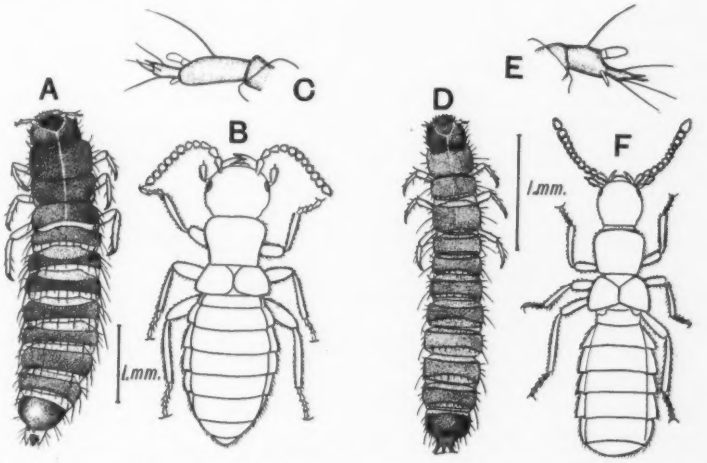

Fig. 9. *Liparocephalus brevipennis.* A, larva, dorsal view; B, adult, dorsal view; C, larval antenna. *Diaulota densissima.* D, larva, entire; E, larval antenna; F, adult.

The larvæ of *Liparocephalus* (Text-Fig. 9, A) are much larger and stouter than those of *Diaulota*, of a dark greyish color readily distinguishable from the light reddish brown of the smaller species (Text-Fig. 9, D). No adults were observed to feed at all, but in the laboratory larvæ would kill and eat pupæ of the Chironomid *Paraclunio* and would sometimes feed on the dead bodies of larvæ of that species and of *Camptocladius*. Doubtless the death of the algæ during the summer accounts for the disappearance of the beetles and their subsequent reappearance during the winter.

SUMMARY.

Eight species of insects collected between tide levels on weed-covered rocks at various points on the coast of British Columbia are discussed. Their larvæ and pupæ all occur in the matting of filamentous algæ on the rocks at various levels. The adults may be found running over the rocks, "dancing," or swarming round the rocks as the tide recedes.

Specific descriptions are given of three new species of *Camptocladius* (Diptera, Chironomidæ) in all stages, under the names *pacificus*, *marinus*, and *clavicornis;* these show successive stages of degeneration towards the morphological adaptations typical of the modified marine Chironomidæ.

Paraclunio alaskensis (Coq. Diptera, Chironomidæ) is recorded as marine for the first time, and the early stages described. The most striking feature is the obliquely truncated disc terminating the pupal abdomen, which was described by Schiner for *Telmatogeton sancti-pauli* and which occurs in the Hawaiian genus *Charadromyia*. The adult belongs to the group of the Clunioniæ with trilobed tarsi; the partially rotated male hypopygium and the protrusible anal tube are described, besides other peculiarities of the species.

The record of *Dicranomyia signipennis* Coq. as marine makes it the third known marine Tipulid in the world. It breeds in large numbers on suitably rocky shores, the adult males swarming round the rocks at every receding tide in the spring. No modifications attributable to the marine habitat are noticeable beyond the usual loss of the anal blood-gills of the larva.

Aphrosylus praedator Wheeler (Diptera, Dolichopodidæ) is very plentiful in all localities, though the larvæ being predaceous wander singly through the algæ and are not readily found. The larvæ and adults were known to Wheeler but the pupæ are newly reported and figured.

Liparocephalus brevipennis Mäklin and *Diaulota densissima* Casey (Coleoptera, Staphylinidæ) are small wingless beetles whose larvæ and adults roam the rocks when uncovered by the tide. They are not inconvenienced by immersion in sea-water unless covered for longer than the natural periodicity of the tides, hence they are never found at the lowest tide levels, which are only exposed a few days every month.

The above forms are all predaceous or phytophagous, but a number of saprophagous shore insects were observed whose

larvæ can withstand short immersion in sea-water. The following, all Diptera, are recorded but not discussed: *Tethina rostrata* (Geomyzidæ), *Megaselida ursina* (Phoridæ), *Scatella stagnalis* (Ephydridæ), *Hilara* sp. (Empidæ), *Fucellia fucorum* (Anthomyidæ), *Heteromyza glauca* (Helomyzidæ).

ACKNOWLEDGMENTS.

I desire to thank the Biological Board of Canada for the laboratory and travelling facilities which made this investigation possible, and particularly Dr. W. A. Clemens, Director of the Nanaimo Station, for his encouragement and assistance at all times, for the use of his private library, and for observations and collections made during the winter. The following specialists have kindly lent their services to identify specimens: Dr. C. P. Alexander, Amherst, Mass. (Tipulidæ); Mr. C. H. Curran, Ottawa (Diptera); Mr. M. C. VanDuzee, Buffalo, N. Y. (Dolichopodidæ); Mr. W. J. Brown, Ottawa, (Coleoptera). To Mr. F. W. Edwards of the British Museum I am greatly indebted for constant help in the systematics of the Chironomidæ. Mr. E. H. Bryan, Jr., Dipterologist, Bishop Museum, Honolulu, has kindly furnished specimens of *Charadromyia* for comparison and obtained for me a copy of Terry's paper on that genus.

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A REVIEW OF MYZOCALLIS SPECIES INHABITING ALNUS, WITH DESCRIPTION OF A NEW SPECIES (HOMOPTERA, APHIIDÆ).*

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Introductory Remarks.

The first Myzocallis species inhabiting Alnus was described by De Geer (10) in 1773 under the name *Aphis alni*, which is a common European species. Both, European and American aphidologists, attributed this species to Fabricius, citing to p. 215 of his Entomologia Systematica (8). This, no doubt, is an erroneous attribution, because Fabricius only listed the species with reference to De Geer, stating: "*Aphis alni* flavescenti alba, tuberculata alni. Habitat in Betulæ Alni foliis." De Geer, on the other hand, gave an unmistakable description of the oviparous female, occupying three pages (47-49) of his second memoir with three figures. He not only described the insect, but gave a very interesting account of his observations as to oviposition and the role of the waxy secretion found on the ventro-lateral sides of posterior end of the abdomen. On the strength of this, this species should be ascribed to De Geer rather than to Fabricius.

In 1837, Heyden (11) described a species *Aphis maculata* from Alnus leaves. His species, however, proved to be a synonym of *alni* De Geer.

Koch (12), listed *alni* under his newly erected genus, *Callipterus*. In 1860, Passerini (15) erected two genera of interest: *Myzocallis* with *A. coryli* Goetze as a type, and *Pterocallis* with *A. alni* Fab., type of the genus. Later Mordvilko (13) placed *alni* under his *Subcallipterus*.

In 1851, Fitch (9) described an indigenous American species, *Lachnus alnifoliæ*. It was erroneously recorded by many in American literature as *alni* Fabr. under *Callipterus*. Since the genus *Callipterus* being distinct with *Aphis juglandis* Kalt. as a type, it excludes such species as *alni* De Geer and *alnifoliæ*

* Contribution from the Department of Economic Entomology, Wisconsin Agricultural Experiment Station.

Fitch. Realizing this, Wilson (18) in 1910 transferred both species *alni* De Geer and *alnifoliæ* Fitch to *Myzocallis* as being similar to *M. coryli* Goetze, type of this genus. The synonomy of the above mentioned genera is well established by Baker (2), showing that the above genera, with the exception of *Callipterus*, became synonyms of *Myzocallis*, yet, *alni* is still listed by some workers under *Callipterus*, *Pterocallis* and *Subcallipterus*.

The type of *alnifoliæ* Fitch, in so far as it is known, has seemingly been lost. The original description, however, agrees well with the species generally accepted as *alnifoliæ* which is the most common aphid feeding on alder leaves throughout the Eastern, Middle West and Southern States, the region of the original description. Baker (1) in his notes concerning this species removed a great deal of confusion. Now it is generally placed by the American aphidologists in *Myzocallis* with the exception of Oestlund (14), who lists *alnifoliæ* Fitch under *Euceraphis*, dealing however with the species known as *Euceraphis gillettei* Davidson or closely related species.

Davis (4) in 1910 recorded *alni* De Geer from Illinois for the first time as occurring in North America, giving descriptions of alate viviparous, apterous oviparous females and male with drawings of certain characters. In 1919 he (5), referring to Baker's key (1), made an unfortunate correction, stating that it should be *alnifoliæ* Fitch instead of *alni* De Geer. Upon examination of his specimens it became evident that they are different from the species commonly considered as *alnifoliæ* Fitch. When compared with the European material of *alni* De Geer from Belgium and Germany, they were found to agree in all respects. This definitely establishes the record of the occurrence of *alni* De Geer in this country. The specimens collected by Mr. L. G. Gentner in Oregon and a slide received from Miss A. P. Macdougall from British Columbia indicate that this species, though not common, is widely distributed on this continent.

In 1912, Essig (7) gave descriptions with drawings of alate and apterous viviparous females of what is supposed to be *alni* De Geer, collected on *Alnus rhombifolia* Nutt in California, stating that *alnifoliæ* does not occur in that State. On examining the Californian material received from Essig and Davidson and comparing it with the material of *alni* from Europe and that of Davis, it was found to be a different species, as can

be readily seen in the distribution and number of sensoria on the third antennal segment of the alate viviparous females and as given in illustrations by Davis (4) and Essig (7). When it is compared with the species known as *alnifoliæ* Fitch it exhibits marked differences in a number of characters which are pointed out in the following pages. This Californian species was also referred to under the name of *alnifoliæ* (Fitch) by Davidson (3), Essig (6) and Swain (16).

Exactly the same species has been collected by the writer for the last five years in Wisconsin. In some localities it is quite common, much more so than *alnifoliæ*, while in the others, *alnifoliæ* predominates to the exclusion of this new one, which evidently remains unnamed. To remove further confusion it is redescribed in this paper, under the name *Myzocallis rhombifoliæ* n. sp.

Takahashi (17) in 1921 described an interesting species, *Myzocallis pseudoalni*, from Taihoku, Formosa, Japan, taken on leaves of Alnus. This species has not yet been reported from this continent.

The following keys will separate the above mentioned species:

KEY TO THE SPECIES OF MYZOCALLIS INHABITING ALNUS.

Alate Viviparous Females.

1. Wing veins uniform and broadly banded with brown.....*pseudoalni* Takahashi
   Wing veins heavier at their bases, lighter distally, without broad brown bands..... 2
2. Basal third of antennal segment III with 2 to 4 sensoria. Distal ends of hind femora with dark brown band-like spots.....*alni* (De Geer)
   Basal third of antennal segment III free from sensoria. Distal ends of hind femora without dark brown spots..... 3
3. The middle of antennal segment III dusky, slightly swollen, carrying from 3 to 6 sensoria. Bases of tibiæ narrowly annulated with dark brown. Abdominal segment two provided with a single finger-like dorsal tubercle.....*alnifoliæ* (Fitch)
   Distal half of antennal segment III dusky with 4 to 10 sensoria usually distally located. Bases of tibiæ without brown annulations. Dorsal finger-like tubercle absent.....*rhombifoliæ* n. sp.

Key to Apterous Viviparous Females.

1. Basal half of antennal segment III with two or more prominent bristle-like hairs.....*alni* (De Geer)
   Antennal segment III without prominent bristle-like hairs..... 2
2. Antennal segment III usually with 1 to 4 small circular sensoria centrally located. Segment IV slightly longer than V.....*alnifoliæ* (Fitch)
   Antennal segment III usually without such sensoria. Segment V slightly longer than IV.....*rhombifoliæ* n. sp.

Key to Alate Males.

1. Entire antennal segment III with 12 to 14 sensoria. Mesa- and meta-femora broadly banded with brown.....*alni* (De Geer)
   Less than entire antennal segment III covered with sensoria..... 2
2. Distal three-quarters of antennal segment III with 10 to 13 sensoria. Bases of tibiæ narrowly annulated with dark brown.....*alnifoliæ* (Fitch)
   Distal half and not more than two-thirds of antennal segment III with 7 to 10 sensoria. Bases of tibiæ usually without such annulations, *rhombifoliæ* n. sp.

Key to Apterous Oviparous Females.

It is similar to that of apterous viviparous females with the exception of oviparous females of *alnifoliæ*, which have conspicuous dark brown annulations on basal ends of tibiæ and cornicles are dusky distally. All of them have swollen hind tibiæ with numerous sensoria.

Myzocallis alni (De Geer) Wilson.

Aphis alni, 1773, De Geer, Mem. pour Servir a l'hist. Ins. *3:* 47–49 (orig. descr. ovip. female, figs.).
Aphis alni, 1794, Fabricius, Ent. Syst. *4:* 215, (desr.).
Aphis maculata, 1837, Heyden, Ent. Beitrage, Muse Sencken. *2:* 297, (descr. male and female).
Callipterus alni (Fabr.), 1856, Koch, Die Pflanzenlause, p. 211, (descrip. alate and apt. vivip. females, figs.).
Pterocallis alni (Fabr.), 1860, Passerini. Gli Afidi, p. 28, (Key, type species).
Subcallipterus alni (Fabr.), 1894, Mordvilko, Lab. Zool. Cab. Warsaw Imper. Univ., p. 53 and 63, (descriptive key and notes).
Myzocallis alni (Fabr.), 1910, Wilson, Can. Ent. *42:* 256, (notes).
Callipterus alni (Fabr.), 1910, Davis, Jour. Ec. Ent. *3:* 416. (Descr. sexes and alate vivip female. First record from the U. S.).

Alate Viviparous Female. (Plate XXXI, Figures 3, 14 and 15).

General color greenish yellow; head, prothorax, and often abdomen pale yellowish with greenish tint. Abdomen with green transverse band over the first two abdominal segments, and green areas around the cornicles which are often united. Thoracic lobes pale brownish yellow. Eyes red. Antennæ pale yellow with dark brown annulations at distal ends of segments III, IV, V and VI; unguis light brown; segment I slightly gibbous and inner side is marked with dark brown to black. Cornicles almost black with the exception of pale yellow bases. Legs pale yellowish; distal ends of hind femora with dark brown band-like spots; apices of tibiæ have a very light brownish tinge; tarsi dusky. Anal plate and cauda pale yellow. Wings hyaline; veins somewhat heavier at their bases and lighter distally; the base of anal vein with conspicuous but small bulla; anal vein being the heaviest, black and slightly bordered with brown; other veins only at their bases and tips very imperceptibly marked with brown; radial sector incomplete; stigma yellow with pale brownish areas at each end.

Length of body about 1.44 mm. Length of antenna—1.488 mm. Comparative average lengths of antennal segments as follows: III—32.3; IV—210; V—17.6; VI—7.7 plus 6.8. Antennæ placed on small antennal tubercles; antennal segments stout and armed with a few short bristle-like hairs. Basal third of segment III with 2 to 4 circular sensoria

placed in a row. Distal ends of all antennal segments slightly imbicated. Frons with a few slender hairs. Body is almost naked, only small, inconspicuous lateral tubercles are provided with very small hairs. Dorsal finger-like abdominal tubercles absent, or reduced to very small, blunt projections not larger than the lateral abdominal tubercles in size, each bearing a small bristle-like hair. Cornicles truncate, rather broad and not conspicuously constricted in the middle. Cauda knobbed; anal plate bifid, and both provided with long bristle-like hairs. Rostrum with dark brown tip reaching beyond the first pair of coxæ. Wing venation normal, typical of the genus.

Described from 15 specimens collected in Europe and in America.

Apterous Viviparous Female. (Plate XXXI, Figures 5, 16 and 17).

General color a very pale greenish yellow or almost white, with transverse greenish bands at the anterior part of the abdomen and the irregular darker green areas around the cornicles. Eyes rusty-red. Antennæ pale; distal ends of segments III, IV and V annulated and the entire segment VI with the unguis marked with dusky brown. Cornicles pale at the base and brown apically. Legs pale or pale yellow; hind femora with dark brown spots at ante-apical ends; tarsi dusky. Cauda and anal plate pale yellow. Body hairs pale yellow.

Length of body—1.4 mm. Length of antenna—1.328 mm. Comparative average lengths of antennal segments as follows: III—25.3; IV—14.2; V—12.7; VI—6.6 plus 6.2. Antennæ placed on very inconspicuous frontal tubercles; antennal segments robust and provided with short bristle-like hairs; segment I and II each armed with one long stout hair; basal half of segment III usually with 2 and rarely with 3 or more long conspicuous spine-like hairs. Frons with three pairs of large stout hairs. Body flat and thickly covered with long heavy hairs each arising from small tubercle. Cornicles truncate, wider at the bases, somewhat constricted near the ends. Cauda knobbed; anal plate bilobed and armed with finer hairs than the body. Rostrum short, slightly reaching beyond the first pair of coxæ.

Described from nine individuals of European and American origin.

Apterous Oviparous Female. (Plate XXXI, Figures 9, 19, 20 and 31).

General color as given for the apterous viviparous females. In older individuals variations of bright yellow to orange may predominate. Eyes red. Color of antennæ, legs, cornicles, cauda and anal plate as in apterous viviparous females. Body hairs often dusky yellow to gray in color.

Length of body—1.714 mm. Length of antenna—1.072 mm. Comparative average lengths of antennal segments as follows: III—23.2; IV—12.6; V—11.6; VI—6.8 plus 5.5. Antennæ placed on hardly perceptible antennal tubercles; antennæ much as in the apterous viviparous females and are provided with a few small bristles; the

basal half of segment III armed with 2 or 3 long and prominent hairs. Body drawn out posteriorly and thickly set with stout tubercular hairs, which are slightly knobbed or widened at their ends. Frons, cornicles and rostrum as in the apterous viviparous females. Hind tibiæ swollen and covered with numerous rather large sensoria. Cauda broad, knobbed; anal plate entire. Ovipositor slightly drawn out. Just beneath the cornicles on each ventro-lateral side of segments 5, 6 and 7 of the abdomen there is an extensive group of wax pores which secrete flocculent silvery white waxy threads. This waxy material appears as two well defined pads. It is probably used for the protection of eggs at the time of oviposition.

Described from 16 specimens of American collections and 7 examples from Europe.

Specimens of oviparous females from Europe agree in all particulars with the American material with the exception of relatively shorter antennal segment III and the number and distribution of long hairs on antennæ. They often have the entire segment III provided with from 2 to 5 and segment IV with 1 to 2 long and prominent bristle-like hairs.

Alate Male. (Plate XXXI, Figures 12, 18 and 21).

General color pale yellowish light green with the darker green markings as described for the alate viviparous females. Head and thorax dark dusky brown to almost black. Eyes large, red. Frons black. Antennæ dusky with yellowish tinge, and lighter bases. Antennal segment I dark dusky, inner side black. Cornicles black on apical ends and greenish at the bases. Legs pale yellow; meso and meta femora dark dusky brown with black band-like spots at the distal ends; tibiæ dusky, especially the hind pair; tarsi blackish. Lateral abdominal tubercles slightly touched with black. Cauda dusky brown; anal plate brownish. Claspers black. Wings hyaline; markings as in the alate viviparous females.

Length of body—1.28 mm. Length of antenna—1.33 mm. Comparative average lengths of antennal segments as follows: III—29.5; IV—17.9; V—15.0; VI—7.75 plus 6.1. Antennæ situated on small frontal tubercles. Antennal segments are provided with small hairs. Secondary sensoria distributed as follows: entire segment III covered with 12 to 17, usually 12 to 14 rather large sensoria in a row; IV—from 3 to 8, usually 5 to 7; V—3 to 5 plus the usual primary sensorium at the end of the segment; VI—carries from 0 to 2 secondary sensoria and the usual primary one at the base of the unguis. Frons with a few very small, fine hairs. Body almost free from hairs with the exception of a few small hairs arising from body tubercles. Cornicles small, without constriction in the middle. Cauda knobbed; anal plate entire. Wing venation normal.

Described from 4 specimens collected by J. J. Davis, Chicago, Illinois.

HOST PLANTS: *Alnus glutinosa* Geutn., *Alnus* sp.

TYPE LOCALITY: Europe.

This species, according to Davis "is rather common on the lower surface of the leaves of alder in Chicago parks, and when abundant, as it often is, the upper surfaces of the lower leaves become heavily coated with honey dew."

The following material was used for study of this species, collected by:

J. J. Davis, Chicago, Ill., October 1, 1908, *Alnus* sp., 1 slide.
J. J. Davis, Chicago, Ill., October 4, 1909, *Alder*, 4 slides.
J. J. Davis, Chicago, Ill., October 20, 1909, *Alder*, 1 slide.
L. G. Gentner, Corvallis, Ore., October 17, 1913, *Alder*, 1 slide.
A. P. Macdougall, Beaver Lake, B. C., Canada, August 25, 1924, *Alnus* 1 slide.
M. H. Schouteden, Brussels, Belgium, (date and host?), 1 slide. (U. S. N. M. No. 77).
From H. F. Wilson, Stettin, Prussia, July 31, 1898, *Alnus* sp., 1 slide.

These records indicate the present distribution of this species on the North American continent.

Myzocallis alnifoliæ (Fitch) Wilson.

Lachnus alnifoliæ, 1851. Fitch, Rept. Reg. Univ. State N. Y. Cab. Nat. Hist., p. 67, (orig. descr., male).
Myzocallis alnifoliæ (Fitch), 1910. Wilson, Can. Ent. *42:* 257, (list).
Pterocallis alni (De Geer), 1922. Oestlund, 19th Rept. Sta. Ent. Minn., p. 137, (Note).
Euceraphis alnifoliæ (Fitch), 1922. Oestlund, 19th Rept. Sta. Ent. Minn., p. 134, (List, notes). (Probably *Euceraphis gillettei* Davidson).
Myzocallis (*Callipterus, Pterocallis*) *alni* (Fabr.), by some American authors.

Alate Viviparous Female. (Plate XXXI, Figures 2, 22, 23 and 24).

General color pale yellow with greenish tinge; head and thorax only shade darker yellow or very light orange. Abdomen almost uniform in color varying in deeper greenish irregular shadings around the cornicles, anterior and posterior segments and along the lateral sides. This shading is variable and often imperceptible. Eyes red. Antennæ very pale yellow with rather narrow black or dark brown annuli at the end of each segment except the first two which are concolorous with the body; unguis dusky. The sensoriated middle of segment III usually dusky or dusky brown to black. Cornicles pale, upper third being marked with brownish black. Legs pale yellow; proximal ends of tibiæ just at the joint touched with brownish-black bands; in older individuals entire length of inner sides of tibiæ are often slightly shaded with light dusky brown. Tarsi dusky or brown. Cauda and anal plate pale with yellowish tint. Wings hyaline; venation as in the preceding species, only anal vein is much heavier and broader banded with dark brown along its distal two thirds; the proximal third is lighter without brown shading; the base of anal vein provided with a very large brownish black conspicuous bulla. Radial sector only faintly indicated.

Length of body—1.5 mm. Length of antenna—1.648 mm. Comparative average lengths of antennal segments as follows: III—42.8; IV—22.2; V—19.3; VI—9.3 plus 9.1. Antennæ placed on small inconspicuous tubercles. Antennal segments long and slender, almost naked, with distal ends slightly imbricated. Antennal segment I gibbous. Middle of antennal segment III swollen, carrying from 2 to 8, usually from 3 to 5 rather large circular sensoria. Frons with a few fine hairs. Abdomen with very small lateral tubercles provided with short hairs. First and second abdominal segments along the dorso-logitudinal axis are provided with one tubercle each; dorsal tubercle on first segment is very small and often inconspicuous, the one on the second segment is a long, finger-like process with brownish apex. Cornicles truncate, longer than broad, wider at the bases and somewhat constricted at distal third of the length. Cauda distinctly knobbed, hairy with a wart-like tubercle at the base. Anal plate bifurcate, armed with long bristly hair. Tip of rostrum brown, reaching beyond the first pair of coxæ. Wing venation normal.

Described from 27 specimens collected in Wisconsin and compared with abundant material from Eastern and Southern States.

Apterous Viviparous Female. (Plate XXXI, Figures 6, 25 and 26).

General color varies between a yellowish pale green and a very pale yellow to white, with darker green irregular patches as in the alate form. Eyes red. Antennæ pale; antennal segments III and IV with only very faint narrow dusky annuli if any; segments V and VI with broader, more pronounced dusky annulations; unguis slightly dusky. Cornicles concolorous with the body, without or with very faint dusky marking at apices. Legs pale or yellowish pale; tarsi brownish. Cauda and anal plate concolorous with the body. Body hairs from yellow to dusky brown, often concolorous with the body.

Length of body—1.129 mm. Length of antenna—1.024 mm. Comparative average lengths of antennal segments as follows: III—22.8; IV—11.3; V—10.7; VI—6.3 plus 5.6. Antennal tubercles wanting; antennal segment I gibbous; segments I and II each bearing one conspicuous clavate hair; segment III usually, but not always, with 1 to 4 circular sensoria, often obscure. Primary sensoria on V and VI present. Segment III as a rule slightly longer than the width of head across the eyes. Frons with three pairs of long, stout, clavate hairs. Body dorso-ventrally depressed, clothed with similar hairs, each arising from a small fleshy tubercle. Cornicles truncate, somewhat conical. Cauda knobbed; anal plate bilobed, both hairy. Rostrum reaching to the second pair of coxæ with its brown tip.

Described from 10 specimens collected in Wisconsin and compared with material from the Eastern half of the United States.

Apterous Oviparous Female. (Plate XXXI, Figures 8, 27, 28 and 32).

General color variable from pale yellow or orange to dark green with a purplish tinge. Eyes red. Antennæ pale yellow, often white; antennal segments III, IV, V and VI as a rule are strongly annulated with black or dusky brown, resembling that of the apterous viviparous females; segments I and II concolorous with the head, inner side slightly dusky. Tips of cornicles are touched with black or at least dusky. Legs pale yellow; tibiæ at femoral joints usually marked with dusky black; tarsi dusky. Cauda yellow, often brownish; anal plate concolorous with the body. Body hairs and their tubercular bases dusky or black.

Length of body—1.424 mm. Length of antenna—1.184 mm. Comparative average lengths of antennal segments as follows: III—24.5; IV—12.6; V—12.4; VI—8.0 plus 7.5. Some individuals have their antennal segments measure approximately as those of the apterous viviparous females. Antennal segments I and II gibbous, each bearing bristle-like clavate hair; the middle of segment III provided with a few small circular sensoria, ranging from 1 to 5, usually 1 to 3, only rarely are they absent. Frons with six strong tubercles, each provided with a hair. Body arched, tuberculate and covered with long, stout, clavate hairs. Cornicles as in the alate viviparous females, although apices may be stronger annulated with brown. Hind tibiæ swollen with numerous but not crowded large sensoria covering proximal two-thirds of the tibiæ. Cauda knobbed; anal plate entire. Ovipositor slightly extended. Sides of the abdomen just beneath the cornicles with argentate waxy tufts produced by cumulus groups of glandular cells of comb-like appearance. Rostrum reaching to the middle pair of coxæ.

Described from 21 specimens collected in Wisconsin and compared with Eastern material. Some individuals from Eastern states have much shorter antennal segments, on the average measuring as follows: III-18; IV-9; V-9; VI-5 plus 4.

Alate Male. (Plate XXXI, Figures 11, 29 and 30).

General color yellowish-green with dusky-brown to black shadings, or olive green with a purplish tinge. Head and thorax shaded with dusky to black tinge of a varying degree. Eyes bright red. Frons shaded with black. Antennæ dusky to almost black; segment III the darkest, with pale yellow base; segment VI and unguis the lightest and only moderately dusky; each segment lighter at the base and darker distally; segment I dusky-black on inner side, and segment II slightly ringed with a dusky shade at distal end. Cornicles annulated with black at apices. Legs pale yellow; femora shaded with dusky brown and ante-apical ends marked with diffused, broad, blackish, dimidiate bands; tibiæ at femoral joints with distinct black bands, outer longitudinal side is deeply shaded with dusky brown to black, which often spreads out over entire tibiæ; tarsi blackish. Cauda and anal plate yellow to very light brown. Claspers dark brown to black. Wings as in the alate viviparous female.

Size of body—1.088 mm. Length of antenna—1.440 mm. Comparative average lengths of antennal segments as follows: III—31.3; IV—17.6; V—17.0; VI—8.7 plus 8.0. Antennæ placed on small antennal tubercles. Antennal segment I gibbous. Antennæ slender and sparsely armed with very small hairs. Secondary sensoria large, circular with definite margins and distributed as follows: distal three quarters of segment III with 8 to 13, usually 9 or 10 sensoria in a row; IV—from 3 to 6, usually 4 or 5; V—2 to 4, usually 3 to 4, plus terminal primary sensorium; VI—without secondary sensoria, but with the usual primary sensorium at the base of the unguis. Frons with very fine hairs. Body almost denudate. Cornicles truncate, slightly enlarged at the bases. Cauda knobbed; anal plate only slightly dented. Rostrum reaching midway between the first and second pairs of coxæ. Wing venation normal.

Described from 11 specimens taken in Wisconsin and compared with material from Eastern and Southern States.

HOST PLANTS: *Alnus incana* Willd., *Alnus rubra*, *A. rugosa*, *A. serrulata* and *Alder sp.*

TYPE LOCALITY: Eastern States of the United States.

This species inhabits the lower sides of the leaves and usually feeds on young terminal leaves singly or in scattered colonies. Apterous forms are common, but not very abundant. The apteræ feed along the veins of leaves.

The following collections in Wisconsin were taken by the writer on *Alnus incana* Willd.:

Aug. 18, '24—Jacksonport, 2 slides.
Sept. 6, '24—Jacksonport, 6 slides.
June 13, '25—Jacksonport, 1 slide.
June 30, '25—Jacksonport, 2 slides.
July 15, '25—Washington Id., 1 slide.
Aug. 12, '25—Baileys' Harbor, 2 slides.
Sept. 13, '25—Jacksonport, 2 slides.
Sept. 18, '25—Sturgeon Bay, 3 slides.
July 24, '27—Jacksonport, 2 slides.
July 27, '27—Sturgeon Bay, 3 slides.
July 31, '27—Baileys' Harbor, 4 slides.
Aug. 29, '27—Sturgeon Bay, 2 slides.
Sept. 1, '27—Jacksonport, 2 slides.
Sept. 10, '27—Spider Lake, 3 slides.

Distribution records of the species are known from the following States: New York, Pennsylvania, Ohio, Maryland, Connecticut, Maine, Massachusetts, South Carolina, Mississippi, District of Columbia, Colorado, Minnesota and Wisconsin. Specimens from these States were used in this study for comparison.

Myzocallis rhombifoliæ new sp.

Myzocallis alni, (Fabr.), 1912. Essig. Pom. Jour. Ent. *4*, no. 3: 761. (Key to Calif. species), 762 (note) 764–7. (Desc. alate and apterous vivip females and figs.), and 826, (host list).

Lachnus alnifoliæ (Fitch), 1910. Davidson, Jour. Ec. Ent. *3*: 375; (note).

Callipterus alnifoliæ (Fitch), 1911. Essig, Pom. Jour. Ent. *3*: 457 and 465, (Host list and synonomy).

Myzocallis alnifoliæ (Fitch), 1919. Swain, Univ. Cal. Pub. Tech. Bul. *3*, no. 1: 22, (notes).

Alate Viviparous Female. (Plate XXXI, Figures 4, 36 and 37).

General color pale yellow with a very light greenish tinge. In some individuals darker green irregular blotches are present over the first two abdominal segments, around the cornicles and along the dorso-lateral sides. Eyes brilliant red. Head and thorax concolorous with the body. In older individuals thoracic lobes may be a shade darker yellow. Antennæ pale, sometimes with a faint yellow tint. Antennæ with wider annulations than in the preceding species; apices of antennal segments II are only slightly touched with light brown rings; distal half of segment III dusky brown, and darker brown to black distally; distal third of segment IV, and distal half of segment V with similar annulations; segment VI and unguis only at apices touched with a light dusky brown. Cornicles concolorous with the body at their bases and only with very faint dusky apical annuli, which are often imperceptible. Legs pale or very light yellow; bases of tibiæ without brown bands, only the outer bases of hind tibiæ are sometimes provided with one minute black dot each; apical halves of tarsi brownish to dusky. Cauda and anal plate pale yellow. Wings hyaline; venation as in the preceding species, only the bulla is relatively smaller and anal vein only slightly shaded with light brown.

Length of body—about 1.0 mm. (average 0.976 mm.). Length of antenna 1.136 mm. Comparative average lengths of antennal segments as follows: III—25.0; IV—14.6; V—12.7; VI—6.4 plus 5.6. Some individuals have slightly shorter antennæ than the length of the body. Antennæ placed on very small frontal tubercles. Antennæ with very short hairs or almost naked; distal ends of segment III and entire length of other segments imbicated. Segment I moderately gibbous. Segment III with a row of from 4 to 9, usually 5 or 6 large circular sensoria as a rule confined to the apical half; sensorated areas somewhat swollen. Frons with a few fine hairs. Abdomen almost denuded of hair. Lateral abdominal tubercles present, but inconspicuous. Dorsal abdominal tubercles absent. Cornicles truncate, longer than broad, wider at their bases, without constrictions or flanges. Cauda knobbed, hairy, with a broad base. Anal plate bilobed, with a few long bristly hairs. Rostrum with its brown tip reaches up to the second pair of coxæ. Wing venation normal. Radial sector only faintly indicated.

Described from 9 specimens collected in Wisconsin and compared with the material from California, through the courtesy of Professor E. O. Essig.

Apterous Viviparous Female. (Plate XXXI, Figures 7, 40 and 41).

General color very pale greenish yellow, almost transparently white; some individuals are with darker green irregular molting as in the alate form. Eyes dark red. Head and thorax concolorous with the body. Antennæ pale white to very light yellow. Antennal segment III only very faintly and narrowly annulated if at all; segments IV, V and VI with more conspicous brown annuli at the distal ends; unguis slightly dusky brown. Cornicles pale or light yellow without apical dusky

brown markings. Legs very light yellow or pale. Cauda and anal plate concolorous with the body. The hairs over the body are transparently white to very light yellow.

Length of body—0.896 mm. Length of antenna—0.752 mm. Comparative average lengths of antennal segments as follows: III—15.3; IV—7.4; V—7.6; VI—5.3 plus 4.6. Antennal tubercles absent or very inconspicuous; antennæ almost bare; antennal segment I gibbous; segments I and II provided with one clavate hair each; segment III the longest, usually without secondary sensoria, although occasionally one may be present but only rarely and very indistinct; segment IV, as a rule slightly shorter than segment V. Primary sensoria on V and VI present. Segment III either shorter or about equal to the width of head across eyes. Frons with three pairs of conspicuously long, clavate stout hairs. Body very small and delicate, tuberculate, dorso-ventrally depressed and covered with very stout, bristle-like clavate hairs, each arising from the body tubercle. Cornicles truncate, somewhat broader at their bases. Cauda knobbed; anal plate bilobed and both provided with hairs. Tip of the rostrum brown, reaching up to the second pair of coxæ.

Described from 11 specimens collected in Wisconsin and compared with the material from California.

Apterous Oviparous Female. (Plate XXXI, Figures 10, 34, 35 and 33).

General color pale yellow to deep orange with greenish tinge. Head and thorax are concolorous with the body. Eyes dark red. Antennæ pale, almost white with faint and narrow annulations at distal ends of segments III, IV and V; segment VI and unguis dusky with the exception of the lighter bases. Cornicles pale yellow without apical dusky markings. Legs uniformly pale or very light yellow and without dusky markings; tarsi distally touched with a faint dusky color. Cauda and anal plate pale yellow. The body hairs conspicuous, pale white or very light yellow.

Length of body—1.264 mm. Length of antenna—0.896 mm. Comparative average lengths of antennal segments as follows: III—18.0; IV—9.33; V—9.4; VI—6.41 plus 6.0. Antennal segments IV and V about equal in length, quite often, however, segment V is slightly longer than segment IV. Segments I and II are provided with one clavate stout hair each; segment I being gibbous; other segments only with a few small bristle-like hairs, almost naked. Secondary sensoria as a rule absent, only rarely basal half of segment III with one very indistinct sensorium. Primary sensoria on segment V and VI present. Frons with three pairs of large clavate hairs arising from small fleshy tubercles. Body elongated, swollen dorsally and clothed with numerous stout, clavate hairs placed on conspicuous fleshy tubercles. Cornicles truncate often pointed upward toward dorso-median line. Each side of the abdomen just beneath the cornicles has rather large silvery tuft of waxy secretion, consisting of many composite threads. In balsam this secretion disappears, revealing the chitinized areas of glandular

structure. Hind tibiæ swollen and provided with large circular sensoria over the proximal two-thirds of tibiæ. Cauda knobbed, anal plate entire and both provided with fine non-clavate hairs. Ovipositor only slightly extended. Rostrum reaching to the middle pair of coxæ.

Described from 10 specimens taken in Wisconsin.

Alate Male. (Plate XXXI, Figures 13, 38 and 39).

General color varies between yellowish green and greenish yellow. Head and thorax are dusky brown, the darkest shading is found over the frons. Eyes large, dark red. Antennæ dusky brown to brownish black; segment I pale yellow with a light dusky shading on inner side; segment II conspicuously annulated distally; basal third of segment III pale, gradually shaded to dark dusky brown and almost black distally; segments IV, V and VI dusky brown with somewhat lighter bases; unguis slightly dusky. Abdomen greenish yellow with slightly dusky sides, especially toward the thorax. Cornicles yellow and only very faintly, if at all, touched with light dusky annuli. Legs yellowish with dusky shadings; femora on outer sides shaded with dusky-brown, while inner side usually almost pale; tibiæ more or less uniformly shaded with light dusky brown, and are without heavy dark brown shadings at the femoral joints; tarsi slightly dusky. Cauda and anal plate yellow with dusky shading. Claspers from dark brown to black. Wing hyaline; venation as in the alate viviparous females.

Length of body—0.704 mm. Size of insect is very small. Length of antenna—1.120 mm. Comparative lengths of antennal segments as follows: III—25.88; IV—14.0; V—13.1; VI—5.8 plus 5.7. Antennæ slender, almost entirely denuded of hairs, and are placed on very small antennal tubercles. Apices of antennal segments imbricated. Antennal segment I gibbous. Secondary sensoria conspicuously large, circular, somewhat protruding and distributed as follows: distal half and not more than two-thirds of antennal segment III with 7 to 10 sensoria usually 8 sensoria in a row; segment IV—from 3 to 5, usually 3; V—from 2 to 3 plus distal primary sensorium; VI—without secondary sensoria, but with usual primary sensorium at the base of the unguis. Frons with a few very fine hairs. Body almost without hairs, cornicles truncate, without enlargement at the bases. Cauda knobbed; anal plate slightly dented. Rostrum reaching up to the second pair of coxæ. Wing venation as in the alate viviparous female.

Described from four individuals collected in Wisconsin.

HOST PLANTS: *Alnus rhombifolia* (Nutt.), *Alnus incana* Willd.

TYPE LOCALITY: Santa Paula, California and Door County, Wisconsin.

PARACOTYPES in the U. S. National Museum; in the collections of Professor E. O. Essig and of the writer.

This species inhabits the lower sides of the leaves, feeding singly or in very scattered colonies. The older leaves are given preference, which are often badly infested. Adults as a rule are feeding along the mid-ribs or along the heavier lateral veins, while nymphs select finer veins or are found feeding on the blades of the leaves. They are seldom, if ever, found on young terminal growth. If they are abundant, the lower leaves of the trees may be liberally covered with a shiny honey dew.

The following Wisconsin collections were made by the writer on *Alnus incana* Willd.:

Aug. 12, '23—Jacksonport, 2 slides.
Aug. 18, '24—Jacksonport, 1 slide.
Sept. 15, '24—Jacksonport, 2 slides.
Sept. 17, '24—Jacksonport, 6 slides.
June 13, '25—Jacksonport, 2 slides.
July 3, '25—Jacksonport, 1 slide.
Sept. 13, '25—Jacksonport, 4 slides.
July 24, '27—Jacksonport, 2 slides.
July 31, '27—Baileys' Harbor, 2 slides.

Distribution records of this species are known from California and Wisconsin. No doubt it probably inhabits the Northern States of this country and Canada.

Myzocallis pseudoalni Takahashi.

Myzocallis pseudoalni 1921. Takahashi, Aphididæ of Formosa, Part I, p. 71, (orig. descr. alate vivip. female).

Alate Viviparous Female. (Plate XXXI, Figures 1, 42, 43 and 44).

General color yellow; thorax pale brownish yellow. Eyes red. Antennal segments I and II concolorous with the body; other segments pale yellow with distal ends of III, IV, V and VI, as well as the middle of segment III broadly annulated with dusky brown. Unguis slightly dusky. Cornicles at the bases yellow, distal halves dark dusky brown to black. Legs yellow with brownish tarsi; distal ends of hind femora marked with brownish bands. Anal plate and cauda yellow. The tips of first and fourth dorsal, finger-like abdominal tubercles dusky brown to black. Wings hyaline with rather heavy uniform veins; the base of the anal vein with small and indistinct bulla; all veins bordered with brown; radial sector sub-hyaline, dark brown distally; stigma pale brown with a clear center.

Length of body—2.0 mm. Length of antenna—2.0 mm. Comparative average lengths of antennal segments as follows: III—43; IV—30; V—25; VI—11 plus 13. Antennæ placed on pronounced antennal tubercles; antennal joints slender and provided with a few short hairs. Apical ends of III and IV, as well as whole V and VI with the unguis imbicated. Basal half of segment III provided with a row of 6-7 well defined circular sensoria. Sensorium at the base of the unguis thickly surrounded with a crown of short sensory hairs and a few auxiliary small sensoria. Frons with several pairs of slender hairs,

somewhat bending over median ocellus. Body furnished with a few hairs. Lateral abdominal tubercles present, each carrying a hair. Second, third, fourth and fifth abdominal segments, along the dorso-longitudinal axis are provided with large finger-like dorsal tubercles, the first being the largest and the fourth one the smallest. Cornicles truncate, longer than broad, somewhat wider at the base and constricted in the middle. Cauda knobbed; anal plate bilobed and both armed with stout, short bristle-like hairs. Rostrum just reaching beyond the first pair of coxæ. Wing venation normal.

Described from three specimens taken by R. Takahashi on *Alnus formosana*, Taihoku, Formosa Island, Japan, April 20, 1920. Material for this description was obtained through the kindness of R. Takahashi.

Host Plants: *Alnus* sp.; *Alnus formosana*. It is sporadic in habit and feeds on lower surface of the leaves. Only alate viviparous females are known. Apterous viviparous females have never been collected. Since this species is evidently tropical in nature, it breeds continually in a viviparous manner, and sexes have never been recorded.

Type Locality: Taihoku, Formosa, Japan.

Cotypes: In the Government Research Institute, Taihoku, Formosa, Japan; in the collections of Dr. R. Takahashi and of the writer.

Comparative Remarks.

The above mentioned species may be separated without much difficulty by the use of keys and descriptions of various forms of respective species. Some species, are, however, more difficult to separate than others, for this reason it will not be amiss to give a brief comparative note in order to facilitate their determination.

Alatæ of *Myzocallis alni* and *M. pseudoalni* resemble each other more than the other two species. They agree in having: radial sector incomplete, more pronounced distally; hind femora toward apices with conspicuous dusky brown patches; distal halves of cornicles black; secondary sensoria placed on basal half of segment III. They disagree as follows:

M. pseudoalni is provided with four dorso-median finger-like abdominal tubercles; wing veins are conspicuously bordered with brown; second fourth from the base of segment III annulated with dark brown or black and basal half of segment III with 5-6 sensoria.

M. alni is devoid of dorso-median finger-like abdominal tubercles; wing veins are without borders with the exception of the anal, and tips and bases of other veins which may have very faint borders; antennal segment III only distally annulated and with 3 or 4 sensoria on the basal third of the segment.

Alatæ of *M. alnifoliæ* and *M. rhombifoliæ* resemble each other more than any of the two preceding species. Both have radial sector only faintly indicated. Wing venation much as in *M. alni.*

They disagree, however, as follows:

M. alnifoliæ is a much larger species than *M. rhombifoliæ;* it has tibiæ at femoral joints ringed with dark brown or black; distal ends of the cornicles distinctly marked with brown or black; the middle of antennal segment III is annulated with brown, swollen and commonly carries from 3 to 6 sensoria; abdominal segment two provided with a single finger-like tubercle.

M. rhombifoliæ is a smaller species; tibiæ without the above annulations; distal ends of the cornicles only faintly marked with dusky brown; distal half of antennal segment III dusky brown with 4 to 8 sensoria distally located; abdomen without finger-like tubercle.

The relative lengths of antennal segments are striking and may serve as additional characters for separation of these species:

TABLE I.

COMPARATIVE MEASUREMENTS OF ANTENNAL SEGMENTS OF ALATE VIVIPAROUS FEMALES.

ANTENNAL SEGMENT	NAME OF THE SPECIES								
	M. alni			*M. alnifoliæ*			*M. rhombifoliæ*		
	Number Examined	Average Length	Variation	Number Examined	Average Length	Variation	Number Examined	Average Length	Variation
III	27	32.3	29–37	30	42.8	39–50	17	25.0	17–30
IV	25	21.0	16–26	28	22.2	17–25	16	14.6	10–18
V	23	17.6	15–22	28	19.3	16–21	16	12.75	9–16
VI	22	7.7	6–9	28	9.3	7–10	15	6.4	5–8
Unguis	22	6.8	6–8	27	9.1	7–10	15	5.6	4–7

Apterous viviparous females are harder to separate than the alatæ. Only three species are known to have apteræ.

M. alni can be at once separated from the other two by having the apices of cornicles black; hind femora with black patches similar to those of alatæ; and the base of antennal segment III provided with the stout, bristle-like conspicuous hairs, numbering from 2 to 4.

The apteræ of *M. alnifoliæ* and *M. rhombifoliæ* are difficult to separate, indeed, for they resemble each other in too many respects and do not possess enough striking characters by which they could be easily distinguished. The character of greatest value is perhaps the presence of small circular sensoria from 1 to 4 in number on the antennal segment III, centrally located in *M. alnifoliæ*, while sensoria are usually absent in *M. rhombifoliæ* and only rarely one is present at the base of the segment. The relationship of relative lengths of antennal segments is also of value especially between the segments IV and V, as well as between the segments IV and VI, together with the unguis. The following table may illustrate the point:

TABLE II.

COMPARATIVE MEASUREMENTS OF ANTENNAL SEGMENTS OF THE APTEROUS VIVIPAROUS FEMALES.

ANTENNAL SEGMENT	NAME OF THE SPECIES								
	M. alni			*M. alnifoliæ*			*M. rhombifoliæ*		
	Number Examined	Average Length	Variation	Number Examined	Average Length	Variation	Number Examined	Average Length	Variation
III	18	25.3	22–29	19	22.8	20–27	22	15.3	11–18
IV	17	14.2	12–18	19	11.3	10–14	22	7.4	4–9
V	17	12.7	11–15	19	10.7	9–13	22	7.6	5–9
VI	17	6.6	6–8	19	6.3	5–7	22	5.3	4–6
Unguis	17	6.2	5–7	19	5.6	4–7	22	4.6	3–6

It will be observed that in *M. alnifoliæ* segment IV is slightly longer than V and that segment VI together with the unguis is about equal to segment IV, or only slightly longer, while in *M. rhombifoliæ* segments IV and V are about equal and often segment V is longer than IV. The segment VI together with the unguis is considerable longer than segment IV. This is true both of averages and variations in lengths of these antennal segments.

The sexual females resemble those of the apteræ, but they are easier to separate, for *M. alnifoliæ* has somewhat faint, yet conspicuous annulations of tibiæ at femoral joints and cornicles

are slightly touched with brown. *M. rhombifoliæ* is more like the apterous viviparous females with the exception of swollen hind tibiæ and waxy secretion.

The males can be distinguished and separated according to key and their descriptions in the text.

Acknowledgments are due to the U. S. National Museum, and the following entomologists for their kindness in loaning the material used in this study: Messrs. G. G. Ainslie, A. C. Baker, J. J. Davis, W. Davidson, E. O. Essig, P. W. Mason, R. Takahashi and Misses A. P. MacDougall and E. M. Patch. Special thanks are due to Professor H. F. Wilson for reading the manuscript and for helpful suggestions.

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EXPLANATION OF PLATE XXXI.

Myzocallis pseudoalni Takahashi.

Alate viviparous female:
1, antenna; 42, cauda and anal plate; 43, cornicle; 44, dorsal tubercle from abdominal segment I.

Myzocallis alni De Geer.

Alate viviparous female:
3, antenna; 14, cauda and anal plate; 15, cornicle.

Apterous viviparous female:
5, antenna; 16, cauda and anal plate; 17, cornicle.

Oviparous female:
9, antenna; 19, cauda and anal plate; 20, cornicle; 31, hind tibia.

Alate male:
12, antenna; 18, cauda and anal plate, showing claspers and copulatory organ; 21, cornicle.

Myzocallis alnifoliæ Fitch.

Alate viviparous female:
2, antenna; 22, cauda and anal plate; 23, cornicle; 24, dorsal tubercle.

Apterous viviparous female:
6, antenna; 25, cauda and anal plate; 26, cornicle.

Oviparous female:
8, antenna; 27, cauda and anal plate; 28, cornicle; 32, hind tibia.

Alate male:
11, antenna; 29, cauda and anal plate; 30, cornicle.

Myzocallis rhombifoliæ n. sp.

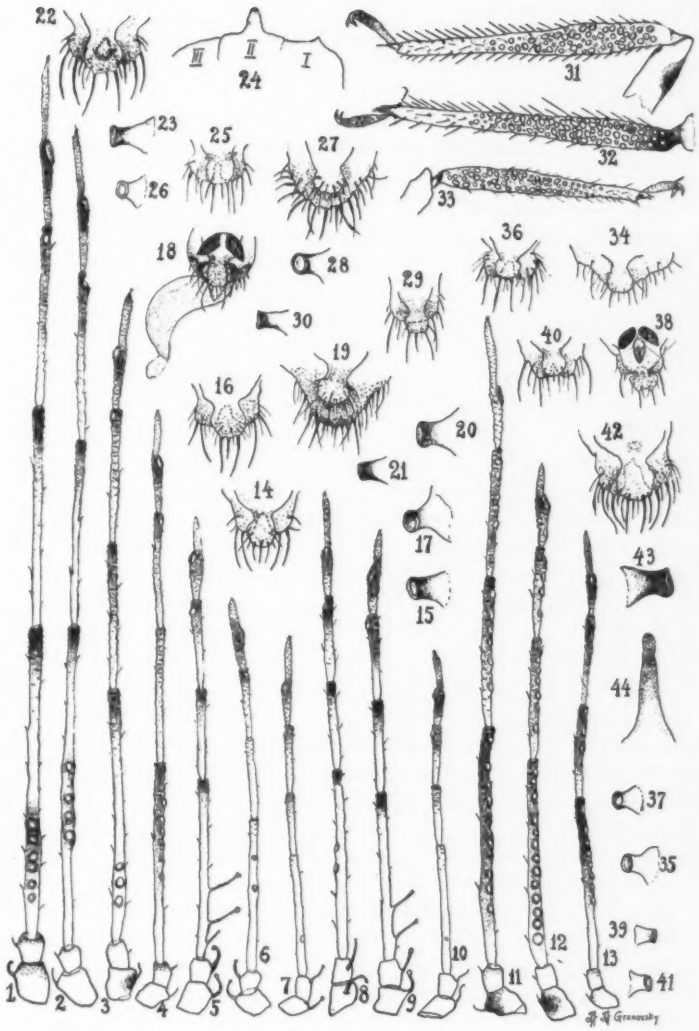
Alate viviparous female:
4, antenna; 36, cauda and anal plate; 37, cornicle.

Apterous viviparous female:
7, antenna; 40, cauda and anal plate; 41, cornicle.

Oviparous female:
10, antenna; 34, cauda and anal plate; 35, cornicle; 33, hind tibia.

Alate male:
13, antenna; 38, cauda and anal plate; 39, cornicle.

NOTE.—All drawings on this plate are made to the same scale.



A. A. Granovsky.

DESCRIPTION AND IDENTIFICATION OF SOME CHIRONOMID EGG MASSES.

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The identification of Chironomid egg masses is a definite problem for the biologists who are investigating the means for lessening stream pollution, particularly that caused by dairy wastes. In 1920-22 investigators were making a study of aquatic insects relative to stream pollution and for this study experimental pools were established at the Fish Hatchery of Cornell University. In these pools appeared egg masses differing from the species with which the pools were originally stocked.

In the endeavor to ascertain the species of these masses, we found a need for recorded descriptions of the same, as the literature on this subject is meager. Malloch (4) in his Chironomidæ of Illinois figures and briefly describes one mass, *Cricotopus trifasciatus* Panzer, among a list of 341 figures. Tilbury (7) figures an egg mass of *Chironomus cayugæ*, Johannsen. Mitchell (5) figures and describes *Chironomus poecilopterus*. Munsterhjelm (6) figures and describes a great number and is an extensive reference, but includes very few of our species.

While striving to reach a classification by comparison of sketches, we became convinced that photographs give the best general aid, and we then undertook to record our findings by this means. Pen drawings are a necessity for microscopic detail, but even here the photograph may catch characters which need to be sought later on. These gelatinous masses will not keep indefinitely in any preservative or the egg mass is to be incubated and the photograph is the only record. Due to the gelatinous matrix in which the eggs are embedded, the masses do not retain their shape unless in a liquid. These photographs were made from masses under water and as the negatives were not retouched, there is a crudeness of texture, but the truth remains.

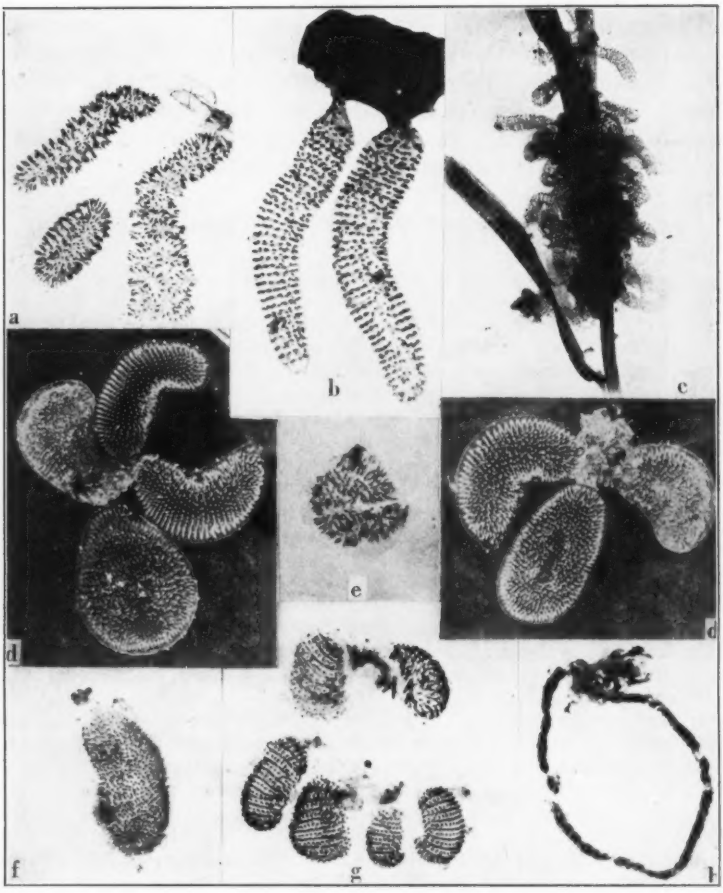
As we found no literature relative to our material, we reared adults from these egg masses and determined the adults. In these determinations, we are indebted to Dr. O. A. Johannsen of Cornell University, whom we wish to thank for his assistance. In two cases, *Ch. decorus* and *Ch. cristatus*, we were fortunate in having the reared adults mate and lay eggs in captivity, thus re-confirming our determinations.

Chironomus cristatus Fabricus.
(Fig. b).

Although the record of this egg mass is published in another place (1), we place it here in order to bring all of the work into a unit. This egg mass is a golden brown and varies in length from 5 to 10 mm. and in width from 1 to 2 mm., the number of eggs in the mass range from 255 to 1440. The mass is an arcuate tapering cylinder, and the eggs lie in a gelatinous flat ribbon which row upon row forms the structure. In laying the mass, the female extrudes a double strand of cords about which the ribbon, which is extruded simultaneously with the cords, is wound. The first end of the egg ribbon is attached to the cords about 1 mm. from its free end, and the female then moves her abdomen back and forth about the cords, forming a hollow cylinder with a "seam" on one side. The last two or three rows of eggs are wound spirally and fastened to the double strand of cords, thus closing the mass and drawing the cords to a central position in the cylinder. The female throws the mass, which has been lying upon her hind legs for support, against the plant (Fig. c) or structure upon which she has been standing, and the free end of the double strand acts as an attachment by which the egg mass is suspended to some object. The mass lies beneath the surface film and floats upon its attachment. Its favored place in the stream is on the downward side of the current where it is not lashed too severely. The cord down the center is apparently a lotic adaptation (see reference 1, Plate V, Fig. 30), for when the current is swift or some enemy pulls at the egg mass, the whole may stretch to five times its original length and come back to normal when released. The shorter side, of the arcuate cylinder, is the "seam" side of the mass. In this species, we obtained the egg masses for several generations in captivity without finding any specific variations.

Chironomus decorus Johannsen.
(Fig. d).

This egg mass is described, but not figured by Chi Ping (3). It is of pale cream colored eggs set in transparent gelatine (a black background was necessary in order to photograph it) and it is laid in the same manner as *Chironomus cristatus*. It is about 9 mm. in length and 5 mm. in width at its widest diameter. The shape is cylindrical and usually arcuate and in some positions resembles a small pear.



EGG MASSES OF CHIRONOMIDÆ, PHOTOGRAPHED IN WATER.

a = two undetermined species. b* = Chironomus cristatus, Fabricus. c = Chironomus cristatus on a stem of grass. d = Chironomus decorus, Johannsen. e = Procladius umbrata. f = Chironomus tenellus? g = Tanypus dyari, Coquillet. h = Orthocladius obumbrata, Johannsen.

* This photograph was made by P. W. Claassen, Cornell University, whom we wish to thank for his aid in this work.

The double gelatinous cords extend through the hollow cylinder and act as an attachment, but many of the masses are found on the bottom of the pool.

Tanypus dyari Coquillet.

(Fig. g).

This mass is distinctly different from the two above as the matrix or gelatine of the mass is dense and opaque. The masses retain their shape when removed from the water, while those described above are flaccid and loose their characteristic outline. The mass is laid upon any support that may project above the water line, and does not float freely. The egg mass rests in the surface film, and on a casual observation will appear to be out of the water. The eggs which are very dark, brown or black, lie in a ribbon which has been passed back and forth forming a mass which is rounded upon one side and flattened upon the side next to the support. There seems to be an absence of eggs on the flattened side, possibly because they could not be aerated here. The mass measures about 8 mm. in length and from 4 to 5 mm. in width, is slightly oval in outline and about 3 mm. thick. There are from one hundred and fifty to two hundred and seventy eggs in each mass.

Tanytarsus fatigans Johannsen.

The developmental stages of this species were ascertained through this work and are published (2). The egg masses are discs of creamy white eggs in transparent gelatine, and are found lying flat upon supports above the edge of the water, but in positions to receive the spray from small water falls. The discs are about 5 mm. in diameter, and not over 1 mm. in thickness. Frequently the masses appear larger as they are made up of several discs that float free when submerged in water. The discs are formed of short ropes of eggs, two eggs wide and two eggs deep.

Orthocladius obumbratus? Johannsen.

(Fig. h).

Our material here was not abundant, and while we feel reasonably sure of the identification, we offer it reservedly. This mass is a rope of pale green eggs in transparent gelatine that holds its shape only when in water. The egg mass is attached at both ends to aquatic plants or other structures, and is below the water line. The ropes are cylindrical and from 25 to 30 mm. long and 0.8 mm. in diameter. The eggs become dark purplish green just before hatching, and lie in the center of the strand about three deep in a space 0.3 mm. wide. This central strand of eggs is covered with two layers of matrix, the outer one of which is fluted. There are five hundred to six hundred eggs in each rope.

Procladius umbrata.

(Fig. e).

This species was reared from a spherical mass of about 4 mm. in diameter. The eggs are irregularly placed in the matrix, and there is a wide border of gelatine in which no eggs appear. The eggs are pale when first laid, but soon turn dark, and are black when hatching time arrives.

From time to time, we hope to collect more egg masses and make identifications, our aim being to build a key for the Egg Masses of Chironomidæ.

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BOOK REVIEW.

LEAF-MINING INSECTS. By James G. Needham, Stuart W. Frost, Beatrice H. Tothill. Published by The Williams and Wilkins Company. pp. i-vii, 351. 1928.

This interesting book is a comprehensive treatment of the insects which mine into the leaves of various plants and brings together a very complete assemblage of the published matter on this subject, with considerable additions of new matter secured by the authors. The first chapter covers the general habits of the species and includes an interesting discussion of the origin of the leaf mining habits and suggestions concerning methods of study of these insects. In the second chapter there is a short general discussion of the economic aspects and the remaining chapters cover the treatment of the species arranged by orders; a detailed list of leaf-mining insects, and a final very complete chapter of bibliography.

In the preface the senior author has adopted the laudable plan of indicating the parts for which the individual authors were responsible.

The volume is handsomely printed and shows but few typographical slips.

H. O.

NOTES ON THE CLASSIFICATION OF NEARCTIC COLEOPTERA.

MELVILLE H. HATCH.*

It is axiomatic in science that a book becomes partially obsolete even while it is going through the press. A checklist of Coleoptera is no exception to this rule. The present paper has been drawn up to indicate, in part, some of the more important revisions now necessary in the Leng checklist[1], in part to exhibit some of the personal reactions of the author to the classification of the major groups of the order. The supplement to the Leng catalogue[2] indicates new species, but only to a limited extent shows such rearrangements in the sequence of genera and species as have become necessary since 1918. Future papers on Coleoptera by the author will, for the present, follow the sequence of familes established in this paper.

I. THE POSITION OF THE COLEOPTERA IN THE PTERYGOTE SERIES.

Handlirsch (Die Fossilien Ins. 1908, p. 1290-1293; Schroder's Handb. d. Ent. III, 1922, p. 354, 363) is the only modern author who seems to have recognized clearly the polyphyletic origin of endopterygote insects. Neither Crampton (Jr. N. Y. Ent. Soc. XXXI, 1923, p. 102; Jr. Ent. Zool. XVI, 1924, p. 35 Tr. Am. Ent. Soc. LII, 1926, p. 240) nor Tillyard (Ins. Austral. N. Zeal. 1926, p. 8) admit this is their formal schemes of classification, though the latter author's Protocoleoptera[3] seems to represent an order intermediate between Protoblattoidea and Coleoptera.

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[1]Leng, C. W. 1920. Catalogue of the Coleoptera of America North of Mexico.

[2]Leng and Mutchler. 1927. Supplement (1919 to 1924, inclusive), to the Catalogue of the Coleoptera of America North of Mexico.

[3]Tillyard, Proc. Linn. Soc. N. S. W. XIX, 1924, p. 429–435, fig.; Ins. Austral. N. Zeal., 1926, p. 186–187, 472, fig. R16. Myers, Psyche XXXIII, 1926, p. 94. Hatch, Bull. Brook. Ent. Soc. XXI, 1926, p. 193. Forbes, Psyche XXXV, 1928, p. 32–35.

In the following Table I have attempted to divide the pterygote insects into five superorders and to indicate further subdivisions or series for the Orthopteroidea. In my view the Palaeodictyopteroidea represent the ancestral group from which each of the other four superorders has directly descended. Due to the fragmentary nature of the remains, it is impossible to place the Protocoleoptera, but it probably lies somewhere between the Panplecoptera and Pancoleoptera.

A¹. Wings outspread at rest; immature forms aquatic..PALAEODICTYOPTEROIDEA
A². Wings folded when at rest.
  B¹. Hind wings as large or larger than fore-wings; mandibulate; feeble fliers with a strong tendency to become ground inhabitants, ORTHOPTEROIDEA
    C¹. Cerci segmented.....**Panplecoptera**
    C². Cerci unsegmented.....**Panorthoptera**
    C³. Cerci absent; metamorphosis complete.....**Pancoleoptera**
  B². Fore wings as large or larger than hind wings.
    C¹. Metamorphosis incomplete; cerci vestigial.
      D¹. Mandibulate or with sucking mouthparts not born in rostrum formed by labium.....ANOPLUROIDEA
      D.² With sucking mouthparts born in rostrum formed by labium; ground forms.....HEMIPTEROIDEA
    C². Metamorphosis complete; primarily flying forms; cerci present or absent; mouthparts mandibulate or suctorial.....PANORPOIDEA

II. The Series of the Coleoptera.

The most noteworthy contribution to the study of the general classification of the Coleoptera since the publication of Leng's excellent essay (Cat. Col. Am. n. of Mex. 1920, p. 3-38) is that by Tillyard (Ins. Austral. N. Zeal. 1926, p. 176-248), though Handlirsch's contribution (Schroder's Handb. d. Ent. III, 1923-24, p. 521-708) and Winkler's conspectus (Cat. Col. reg. pal. I, 1924, p. vi) are both important. Forbes (Jr. N. Y. Ent. Soc. XXXIV, 1926, p. 113-115, on the venation and folding of the metapteron) and Tanner (Tr. Amer. Ent. Soc. LIII, 1927, p. 42, on female genitalia) have proposed systems founded in each case on a single structure, and Stickney (Ill. Biol. Mon. VIII, 1913, p. 40-45) has proposed changes in Leng's system on the basis of a study of the head capsule. While nothing is more important than comparative morphological studies, it is ill advised to propose new systems of classification as the result of the study of a single part or structure.

The lampyrids primitive: In recent times it has been suggested that the primitive beetle must have more or less resembled the Lampyridæ. Evidence for this view has been

drawn from the soft flexible, illy adapted elytra of the group (Leng, Cat. Col. Am. n. of Mex. 1920, p. 30) which seem to resemble the leathery mesoptera (fore wings) of their putative blattoid ancestors. Associated with this is another blattoid characteristic of very restricted occurrence in the Coleoptera, namely the undifferentiated and completely chitinous condition of the abdominal tergites. The lampyrids share both these characteristics with the meloids, which are differentiated from them chiefly by their heteromerous tarsi. Moreover, the lampyrid larvæ are campodeiform or blattiform, more or less in accord with a blatotid ancestry. Finally, Graham (Ann. Ent. Soc. Am. XV, 1922, p. 197) has insisted on the primitive condition of the wing venation, and Crampton (Tr. Am. Ent. Soc. LII, 1926, p. 226) has pointed out the primitive structure of the prothoracic sclerites.

It is, of course, not at all likely that all the primitive characteristics will be found concentrated in a single group. Among features that are more primitive in other groups than in the lampyroids may be mentioned; (1) the alula of the elytron in Palpicornia, Staphyliniformia, and Adephaga; (2) the lateral ocelli of the Omaliinæ; (3) the median ocellus of the staphylinid, *Phlaeobium clypeatum* Muell. and some of the Dermestidæ; (4) the distinct tarsi and paired claws, of most adephagid larvæ, but paired claws are found in the first instar larvæ of the Micromalthidæ and Meloidæ, both closely related to the lampyroids. I feel, however, that the weight of these characters is not sufficient to displace the lampyroids from the base of the coleopterous series. This is the more true because the characters in regard to which the lamprids are primitive involve features of the general habitus, which, if they are genuine, should outweigh features in obscure portions of the body.

The chief obstacle, however, to placing the lampyrids at the base of the coleopterous series is the traditional position of the Adephaga in the same position.

The Adephaga not primitive: The precise definition of the Adephaga will vary as the Cupesidæ or Rhysodidæ are included or excluded. The inclusion of these groups leaves the presence of the *oblongum* in the metapteron the only character defining the group, and this is secondarily absent in some Rhysodidæ and some Cicindelinæ. The other features usually used to define the group are not universal within the Adephaga, but are confined to that group.

(1) The *Oblongum* is formed by a pair of medio-cubital cross veins. Forbes (Ann. Ent. Soc. Am. XV, 1922, p. 335-336) supposes that they fuse to bring about the condition found in most Cicindelinæ and Hydrophilidæ. It is impossible to say whether or not this condition was primitive in the ancestral coleopterous metapteron. All other coleopterous metaptera can be derived from the adephagid type by a reduction of the cross veins constituting the *Oblongum*. Whether such has actually occurred may be open to question, especially in view of the strong motive for regarding the lampyrids as primitive. Forbes, apparently, admits the *oblongum* to his hypothetical beetle wing (ibid, p. 346, Fig. 1); Graham (Ann. Ent. Soc. Am. XV, 1922, p. 194, Fig. ix) does not; but Forbes studies were the more extensive of the two.

(2) Subnotal suture: According to Crampton (Tr. Am. Ent. Soc. LII, 1926, p. 224-226) the "propleural" suture of Adephaga is homologous with the pronotasuture of the Polyphaga, all the parts laterad of it are really pleuronotum, and the so-called "pronotasuture" suture is really a secondarily formed suture that Crampton terms the subnotal suture and, hence, is evidence of the derivative rather than the primitive nature of the group.

(3) Galea palpiform: The derivative nature of this characteristic is clearly implied in the modern view of the origin of the maxilla, according to which the galea and lacinia are modified endites of the palpifer and stipes respectively. The condition of the galea in some of the lower insects supports this same view (Crampton, Pr. Ent. Soc. Wash. XXIV, 1922, p. 65-82; Jr. N. Y. Ent. Soc. XXXI, 1923, p. 77-107. Imms, Gen Textb. Ent. 1926, p. 17-19). But Heikertinger (Kol. Rund. XIV, 1928, p. 31) continues to regard the palpiform bi-segmented galea as primitive.

(4) First visible abdominal sternite interrupted by metacoxæ: Most certainly a derivative character, as reference to a cockroach will show.

(5) Larvæ with two claws on feet: The larvæ of the Adephaga have a pair of claws (except Haliplidæ) and a distinct tarsal segment, whereas other familes have the tarsal segment indistinct with only a single claw. However, the first instar larvæ of Micromalthidæ and Meloidæ have paired claws (Imms, ibid, p. 471), so that the adephagid condition is evidently primitive. Insect larvæ in general have only a single claw, but since the Coleoptera arose from the protoblattoids in independence of other heterometabolous insects, evidence from the larvæ of other orders has no pertinancy.

No suborders in Coleoptera: LeConte (Amer. Jr. Sci. XCIV, 1867, p. 42) proposed the Rhyncophora as a suborder to be separated from the balance of the Coleoptera. Lameere (Ann. Soc. Ent. Belg. XLIV, 1900, p. 357) proposed to recognize three suborders: Cantharidiformia, Staphyliniformia, Carabiformia (Fowler, Faun. Brit. Ind. Col. Introd. 1912, p. 45). Ganglbauer (Mnch, Kol. Zeit. 1903, p. 271-319) and Kolbe (Allg. Zeit. Ent. 1903, p. 137-145) proposed to recognize the

Adephaga as a suborder equivalent to the rest of the Coleoptera, which they variously termed Polyphaga or Heterophaga (Fowler, ibid, p. 46-47). Fowler (ibid) recognized these two groups with the addition of a third suborder, Lamellicornia.

The difficulty encountered by all these authors, and the critique to be offered in regard to the suborders proposed is that the Coleoptera, in reality, constitute a very homogenous group, in no sense divisible into the distinct subgroups that are characteristic of such orders as Odonata, Hymenoptera, Lepidoptera, and Diptera. While such groups as the Adephaga, Lamellicornia, Staphyliniformia, and Rhyncophora are more or less distinct groups, none of them are, by themselves, really entitled to rank as equivalent to the balance of the order. The primary divisions of the order are more numerous than previous classifications have indicated, and, in general, are not sharply defined. Whether the term "suborder" or "series" shall be applied to these major divisions is entirely without importance, I have continued the use of the latter and more familiar term doing away with all mention of suborders.

The Series of Coleoptera: In the following key I have attempted to define the chief series of Coleoptera and to indicate a linear sequence for them.

KEY TO SERIES OF COLEOPTERA.

A¹. Metapteron without cross veins; galea usually not palpiform; first visible abdominal sternite not interrupted by coxae; subnotal suture absent (except Hydrophilidae); larvae usually with single claw or legless.
  B¹. Metapteron with media proximad to its fusion with cubitus (Mr.).
    C¹. Antenna not lamellate.
      D¹. Not heteromerous, with fourth segment not reduced; antenna variable, filiform or serrate.....**Serricornia**
      D². Heteromerous; antennae filiform to clavate.....**Heteromera**
      D³. Not heteromerous (except a few males of Cucujidae and Cryptophagidae).
        E¹. Antennae more or less clavate; tarsi variable, but not with fourth segment reduced; segments 1–3 pubescent beneath, the third segment lobed.
          F¹. Antennae longer than palpi.....**Clavicornia**
          F². Antennae shorter than palpi; alula present.....**Palpicornia**
        E². Antennae filiform to clavate; tarsi apparently four-segmented, with true fourth segment more or less reduced; segments 1–3 pubescent beneath, the third segment lobed (except Platypodidae).
          F¹. Gular suture double; palpi flexible.....**Phytophaga**
          F². Gular suture single; palpi rigid.....**Rhyncophora**
    C². Antennae lamellate.....**Lamellicornia**
  B². Mr. absent; alula present.....**Staphyliniformia**
A². Hind wing with oblongum; media present at base; usually with galea palpiform; first visible abdominal sternite divided by coxae (except Cupesidae); subnotal suture of prothorax present (except Rhysodidae); larvae with two claws on feet (except Haliplidae); alula present.....**Adephaga**

Serricornia = Polyformia Leng, except that the Cupesoidea are removed to Adephaga and the Mordelloidea to Heteromera.

Heteromera includes the Mordelloidea and Tenebrionoidea of Leng. Melandryidæ, with open procoxacavæ, should head the tenebrinoid series.

TABLE I.

	Serricornia	Heteromera	Clavicornia	Palpicornia	Phytophaga	Rhyncophora	Lamellicornia	Staphyliniformia	Adephaga
Lateral ocelli.....	D	D	D	D	D	D	D	P	D
Median ocellus.....	D	D	P	D	D	D	D	P	D
Gular suture.....	P	P	P	P	P	D	P	P	P
Antennæ (no. seg.)..	P	P	P	D	P	P	P	P	P
Antennæ (clubbed)..	P	P	D	D	P	D	D	P	P
Antennæ (lamellate)	P	P	P	P	P	P	D	P	P
Palpi (rigid).....	P	P	P	P	P	D	P	P	P
Galea (palpiform)...	P	P	P	P	P	P	P	P	D[1]
Tarsi.....	D	D	D	P	D	D	D	P	P[2]
Tarsi (all similar)...	P	D	P	P	P	P	P	P	P
Subnotal suture.....	P	P	P	D	P	P	P	P	D
Elytra.....	P	P	D	D	D	D	D	D	D
Alula.....	D	D	D	P	D	D	D	P	P[2]
Mr. (loss).....	P	P	P	P	P	P	P	D	P
Abdominal tergites.	P	P	D	D	D	D	D	D[3]	D
1st vis. abdom. ster.	P	P	P	P	P	P	P	P	D[1]
Nervous system.....	P	P	P	P	P	P	D	P	P
Larva (type).....	P	P	P	P	D	D	D	P	P
Larva (endophytic).	P	P	P	P	P	D	P	P	P
Larval claws.....	D	P	D	D	D	D	D	D	P[2]
Totals.....	4D	5D	7D	9D	8D	12D	10D	4D	7D[4]

[1]These characters are primitive in Cupesidæ.
[2]Questionable in Cupesidæ.
[3]Questionable in *Apatetica*.
[4]5D in Cupesidæ.

Clavicornia = Clavicornia of Leng except that the Rhysodoidea are removed to Adephaga and the Tenebrionidea to the Heteromera. Histeroidea should be added at the end of the series.

Palpicornia = Palpicornia of Leng.

Phytophaga: The sequence of families should be that given by Handlirsch: Chrysomelidæ with free larvæ, Mylabridæ and Cerambycidæ with endophytic larvæ. The latter

form a transition to the Rhyncophora with completely endophytic larvæ. In such a classification the Donaciinæ must come last in the Chrysomelidæ, forming the transition to the Cerambycidæ.

Rhyncophora: The sequence of families should be that given by Tillyard: Scolytidæ, Platypodidæ, Anthribidæ, Brenthidæ, Curculionidæ, determined in part by the increasing perfection of the rostrum.

Lamellicornia: The sequence given by Leng is good, but the Trogidæ should be suppressed as a subfamily of Scarabaeidæ.

Staphyliniformia: I have elsewhere suggested a sequence of families in this group, but the Histeridæ should be removed to the Clavicornia.

Adephaga: This series may consist of the two superfamilies Cupesoidea and Caraboidea. In Caraboidea the sequence of familes will be: Carabidæ (with Omophronini a tribe of Carabinæ and Cicindelinæ a subfamily at the end of the carabid series specialized by the loss of the *oblongum* in nearly all general and specialized larval habits), Haliplidæ, Dytiscidæ, Gyrinidæ, Paussidæ, Rhysodidæ.

In Table I, which is an extension of that given by Leng (Cat. Col. Am. n. of Mex., 1920, p. 21), I have attempted to indicate the relative degree of specialization of the several series of Coleoptera. With the exception of the Adephaga, the condition indicated is that of the series' more primitive members.

Discussion: The determination of the linear sequence of a series of related groups of organisms is a difficult and not very important matter. The limitations of a linear sequence in depicting what is, at least, a three dimensional radiation are evident. The procedure that appears most adequate is: (1) to place the most primitive group at the bottom of the series, (2) to arrange the remaining groups in accordance with their lines of radiation, and then, (3) to arrange the several lines of radiation according to the *most primitive member of each.* To attempt to gauge the position of a group in terms of its average or supposedly average constitution is to deal with a nonexistent or intangible abstraction.

The first line of cleavage in the Coleoptera appears to be between the Adephaga and the rest of the series, the basis of the cleavage being the presence or absence of the *oblongum.*

For the present I regard this as a divergent character, neither primitive nor derivative. If we view the Adephaga as exemplified by the Cupedidæ, we have to deal with a much more primitive type than, for instance, a carabid. Its rank will, in fact, be only 5 D, the same as Heteromera, and exceeded only by Serricornia and Staphyliniformia. I believe that the primitive habitus (involving the elytra and abdominal tergites) outweighs larval claws or alula; Adephaga are, therefore, placed at the end of the series.

The distinguishing characteristic of the Staphyliniformia, the loss of Mr., is clearly derivative. The lower members of the group, *Pteroloma* for instance, are extremely primitive, but their primitive character is somewhat exaggerated in the table by the double weighing of the ocelli. I cannot avoid the suspicion that the chitinous abdominaltergites of the Staphylinidæ, etc. have been secondarily acquired as the elytra shortened. With the possible exception of *Apatetica*, the tergites are never absolutely undifferentiated; those covered by the elytra are somewhat, if only feebly, less chitinized than the apical ones. In *Apatetica*, all the abdominal tergites are heavily chitinized, not at all as in the lampyrids, and are, I suspect, a secondarily modification, though I have considerably less reason for this suspicion than I have in the case of the typical staphylinids. But the lower Staphyliniformia are very primitive beetles.

From the Serricornia, and more closely connected with them, diverge (1) the Heteromera, (2) the Clavicornia and closely related Palpicornia, (3) the Phytophaga and almost immediately derivative Rhyncophora, (4) the Lamellicornia. The sequence is uncertain. I place the Lamellicornia last on the basis of antennæ, larvæ, and nervous system, which makes them more derivative than the primitive members of any of the other groups. The lower Heteromera (Mordelloidea) resemble the lampyrids closely in the possession of soft elytra and undifferentiated abdominal tergites. The Clavicornia and Phytophaga exhibit an increased specialization of the tarsi.

In general I have adhered to Leng's sequence except where I have had a definite motive for the contrary. My sequence has many similarities to that proposed by Lameere (Ann. Soc. Ent. Belg. XLIV, 1900, p. 357 quoted by Fowler, ibid, p. 45). It is, of course, in the Serricornia and Clavicornia that the most

difficult problems of classification and the greatest diversity of opinion among authors are at present found. Both these groups are inadequately defined, at present, almost entirely by negative characters. Their further investigation is desirable, but it must be undertaken by a competent coleopterist in the light of characters derived from all portions of the body and all stages of the life cycle.

III. Revisions in the Leng Catalogue.

One of the outstanding desiderata of American coleopterology is a proper evaluation of Casey's genera and species. While it will be necessary in numerous instances to consult the types to establish the status of Casey's species, due to his indiscriminate care in drawing up his descriptions, ordinary judgment and experience are all that are required to establish the true nature of many of them. As regards genera, it is the author's conviction that convenience and utility are best served by the retention of fewer large genera with numerous subgenera. For instance, I would restore to something like their status in LeConte and Horn's *Classification* such genera as *Leptura*, *Anomala*, *Cyclocephala*, *Cryptobium*, *Lathrobium*, *Tachys*, *Pterostichus*, *Amara*, *Platynus*, *Anisodactylus*,—to cite only a few that occur to me at random.

In the following bibliography are listed papers that supplement or replace portions of the Leng *Catalogue*. In instances where genera only are listed or where species are arranged alphabetically under the genus, the Leng list will indicate a natural sequence for the species. References to many keys unaccompanied by a catalogue of species are omitted. These may be ascertained from the author's index to keys (Jr. N. Y. Ent. Soc. XXXV, 1927, p. 279-306).

Phengodidæ Pic, Col. Cat. 93, 1927, p. 3–7.
Melyridæ: Rhadalinæ Pic, Col. Cat. 81, 1925.
Plastoceridæ Schenkling, Col. Cat. 93, 1927, p. 3–7.
Elateridæ Schenkling, Col. Cat. 80, 1925; 88, 1927.
Melasidae Schenkling, Col. Cat. 96, 1928.
Buprestidæ Obenberger, Col. Cat. 84, 1926 (part).
Rhipiceridæ Pic, Col. Cat. 81, 1925.
Melandryidæ Csiki, Col. Cat. 77, 1924 (except Scraptini).
Tenebrionidæ: Eleodes Blaisdell, Pan. P. Ent. II, 1925, p. 78–80.
Cryptophagidæ Schenkling, Col. Cat. 76, 1923.
Monoedidæ Hetschko, Col. Cat. 83, 1926, p. 12–13.
Lathridiidæ Hetschko, Col. Cat. 85, 1926.
Histeridæ Bickhardt, Gen. Ins. 166, 1916.

Hydrophilidæ Knisch, Col. Cat. 79, 1924.
Chrysomelidæ: Donaciinæ Schaeffer, Brook. Mus. Sci. Bull. III, 1925, p. 159–164 **Galerucinæ** Weise, Col. Cat. 78, 1924. **Halticinæ** Heikertinger, Kol. Rund. XI, 1925, p. 68–70 (genera).
Cerambycidæ: Prioninæ Lameere, Gen. Ins. 172, 1919. **Lamiinæ** Aurivillius Col. Cat. 73, 1922; 74, 1923.
Brenthidæ Kleine, Col. Cat. 89, 1927.
Scarabaeidæ: Scarabaeinæ Boucomont and Gillet, Col. Cat. 90, 1927 (Oniticellini, Onthophagini). **Rutelinæ** Ohaus, Col. Cat. 66, 1918 (does not include Casey's 1915 revision). **Cetoninæ** Schenkling, Col. Cat. 72, 1921. **Trichiinæ, Valginæ** Schenkling, Col. Cat. 75, 1922.
Staphyliformia Hatch, Tec. Bull. Univ. Minn. Agric. Exper. Sta. 48, 1927, p. 9–11 (fam.).
Staphylinidæ Hatch, ibid (subfam.). **Silphinæ** Hatch, Col. Cat. 95, 1928 (p. 67–164). **Aleocharinæ** Bernhauer and Scheerpeltz, Col. Cat. 82, 1926, p. 500–798.
Catopidæ Hatch, Col. Cat. 95, 1928 (p. 67–164).
Scydmaenidæ Csiki, Col. Cat. 70, 1919.
Carabidæ: Carabinæ Csiki, Col. Cat. 91–92, 1927. **Calosoma** Breuning, Kol. Rund. XIII, 1927, p. 139–143. **Notiophilus** Casey, Mem. Col. IX, 1920, p. 143. **Omophronini** Semenov-Tian-Shanski, Rev. Russ. Ent. XVIII, 1922, p. 36–44. **Harpalinae** (part) Csiki, Col. Cat. 97, 1918. **Platynus et al** Casey, Mem. Col. IX, 1920, p. 1–132. **Cicindelinæ** Horn, Col. Cat. 86, 1926.
Haliplidæ Zimmermann, Ent. Blatt. XX, 1924, p. 5–16, 65–80, 129–144, 193–208.
Dytiscidæ Zimmermann, Col. Cat. 71, 1920, p. 1–266. **Coelambus** Fall, N. A. Sp. Coelambus, 1919, p. 4–19. **Hydroporus** Fall, Rev. N. A. Sp. Hydroporus 1923, p. 125–129. **Agabus** Fall, Rev. N. A. Sp. Agabus, 1922, p. 9–34.
Gyrinidæ Hatch, Mich. Acad. Sci. V, 1925, p. 443–459 (genera). **Dineutus** Ochs, Ent. Zeit. Frankf. a. M. XXXX, 1926, p. 136–138. **Gyrinus** Fall, Tr. Am. Ent. Soc. XLVII, 1922, p. 305–306.

BOOK REVIEW.

HETEROPTERA OR TRUE BUGS OF EASTERN NORTH AMERICA. By W. S. Blatchley. The Nature Publishing Co., Indianapolis, Indiana. 1926.

A monumental and valuable work by one who has previously published useful treatises on the classification of the Coleoptera and Orthoptera, and who, because of his method of treatment has made possible and practical the easy identification of insects of these orders.

The volume consists of 1,116 pages, 215 figures and 12 plates; 1,253 species of Heteroptera belonging to 40 families, are treated. The first 30 pages are utilized to discuss anatomy and methods of collecting. Keys to the families, genera, and species are given which makes the volume of value to those not specialists in the order.

Another excellent feature of the volume is the bibliography of 672 citations to previous literature.

While the text is illustrated with more than 200 figures, the writer feels that in such a book even more illustrations should have been used.

The author's books on the Coleoptera, Rhynchoptera and Orthoptera are written so that they may be interpreted by workers other than specialists and have undoubtedly stimulated the study of insects in their respective groups. It is hoped that specialists in other orders will heed the recognized need for accurate, monographic treatises which will meet the demand of the general and amateur entomologist.

J. J. Davis.

THE GENUS TANYPUS IN CANADA, WITH A KEY TO THE NORTH AMERICAN SPECIES.

(Diptera, Chironomidae)

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The present paper is intended as a review of the Canadian species of *Tanypus* with new distributional notes and a key to the North American species, also the description of a new species from Iowa. Figures of the wings of several species are included to facilitate identification.

During the past four years the writer has been interested in the genus *Tanypus* in Canada and in 1925, descriptions of nine new Canadian species were presented (Can. Ent. LVII, p. 271) with a key to the species then known to occur in Canada. Subsequently, five additional species, three of them described as new (Can. Ent. LVIII, pp. 64 and 205, 1926) have been added to the Canadian list. Further collecting has increased our knowledge of the distribution of several species and some observations have been made on the habits of the imagines.

Early in the preparation of the present work it was perceived that a key for the identification of all the North American species would be very helpful in the accurate allocation of species. In formulating the present key the writer has been greatly assisted by Johannsen's key (N. Y. St. Mus. Bul. 86, p. 136, 1905) to 24 species. Through the kindness of Dr. T. H. Frison of the Illinois State Natural History Survey Laboratory, the writer has been able to examine specimens of *T. pilosellus* Loew and *T. venustus* Coq. Other material on which the present key and notes are based is included in the Canadian National Collection at Ottawa. To Mr. C. H. Curran of the American Museum of Natural History, the writer is indebted for many helpful suggestions during the preparation of this work.

Johannsen's interpretation (Ent. News XVIII, 400, 1907) of the generic limitations of the genus has been followed thus including all species treated by him as *Ablabesmyia* (N. Y. St. Mus. Bul. 86, 135, 1905). The four species described as

Tanypus by Garrett (Seventy New Diptera, privately published, Cranbrook, B. C., Canada, Dec. 31, 1925) are not *Tanypus* but probably *Protenthes*.

The habits of the species are variable. Pale species of the *melanops-cornuticaudatus* group are usually found resting on the foliage of low shrubs and herbaceous plants and rarely on the trunks of trees. The darker species with banded legs and spotted wings as in the *illinoensis-peleensis* group are very rarely found on foliage but usually rest on the trunks of trees, the bark of which they closely resemble in color. The more intermediately colored, yellowish bodied species with banded wings have been found commonly in both situations and apparently they do not show a preference for either type of environment. Several species have been observed to swarm in large numbers toward evening.

A male specimen collected from vegetation on the northern shore of Lake Okoboji, Dickinson County, Iowa, appears to be new to science and is described as follows:

Tanypus okoboji n. sp.

Male. Length 5 mm. Head, palpi and flagellum of antennæ pale yellowish white. Basal joint of antennæ, pale orange yellow. Dorsum of thorax whitish with three longitudinal yellowish stripes, the median stripe divided by a whitish line. Scutellum shining whitish, metanotum dull yellowish, halteres white. Wings hyaline sparsely clothed with fine whitish pubescence. Legs whitish; all femora, front tarsi except base of basitarsi, mid and hind tibiæ, mid-basitarsi and entire hind tarsi with long pale sub-erect hairs; remainder of legs with short sub-appressed hairs. Anterior basitarsus two-thirds as long as front tibia and twice as long as its adjoining tarsal joint. Abdomen shining whitish; basal fourth of segments 2, 3, 4 and 5, basal fourth and mid-dorsal region to apex of segment 6, basal three-fourths of segments 7 and 8, brownish. Hypopygium whitish. Basal section of genital claspers very similar in shape to *Tanypus cornuticaudatus* with a small dense horn of brownish hairs arising on either side from near base and curving dorsal and inward to approach the elevated inner margin. Apical section of genital claspers short and almost straight as in *Tanypus currani*.

Holotype ♂, Lake Okoboji, Iowa, May 18, 1928, (G. S. Walley); deposited in the Canadian National Collection, Ottawa, Canada.

This species is very similar to *T. nigropunctatus* Staeger but may be easily distinguished by the long hairs on the front

tarsi. From *T. cornuticaudatus* and *T. pilicaudatus* it may be distinguished by the absence of the special tufts of pile on the eighth tergite and from the preceding as well as all other species of *Tanypus* studied by the writer, by the structure of the hypopygium.

KEY TO THE NORTH AMERICAN SPECIES OF TANYPUS.

1. Wings darkened, either banded or spotted 25
   Wings without bands or spots excepting sometimes the crossvein darkened or a faint smokiness near the apical end 2
2. Thorax dull black, abdomen golden yellow, legs and halteres yellow; length 2.5 mm ..... *aureus* Joh.
   Not with all the above combination of characters 3
3. Pale species; thorax whitish or yellowish, sometimes with brown vittae 4
   Darker species; thorax greyish or blackish 17
4. Species 3mm. or more in length 5
   Species less than 2.5 mm. in length 12
5. Wholly yellowish species 6
   Abdomen, at least of the male, with distinct brown fasciae 8
6. Third joint of middle tarsus with a dense fringe of longish, yellowish hairs on apex in front ..... *currani* Walley
   Third joint of middle tarsus without such fringe 7
7. Arms of claspers of male stout, the apex not strongly tapering .... *melanops* Mg.
   Arms of claspers of male longer, moderately narrow, tapering apically ..... *senatus* Walley
8. Eighth abdominal tergite of male with dense cluster of pile on either side, pile sometimes forming horn shaped organs 9
   Eighth abdominal tergite of male with normal hairing 10
9. Eighth abdominal tergite of male bearing a horn-like cluster of golden brownish hairs on either side ..... *cornuticaudatus* Walley
   Eighth abdominal tergite of male bearing a tuft of dense pile on either side, pile not forming horns but curling downward and inward covering claspers ..... *pilicaudatus* Walley
10. Thoracic stripes, metanotum and sternum brown ..... *flavifrons* Joh.
    Thoracic stripes, metanotum and sternum yellow 11
11. Front tarsi with whitish hairs four or five times as long as diameter of tarsi ..... *okoboji* n.sp.
    Front tarsi with only short hairs as on front tibiae .... *nigropunctatus* Staeger
12. Thorax not striped 13
    Thorax with longitudinal stripes 14
13. Legs light yellow throughout; abdomen infuscated near the tip (St. Vincent Island) ..... *flaveolus* Will.
    Legs yellow in part but with all femora, front tibiae and apices of mid and hind tibiae pale brownish yellow; basal segments of abdomen with brownish ..... *pilosellus* Loew
14. Abdomen pale yellow; the male with segments two to five with a band near the base and nearly the whole of the following segments pale brownish; mouth parts brown; R_2 present near the tip of R_1; length 1.25 to 2.5 mm ..... *pallens* Coq.
    Not as above; basal cells of wing short 15
15. Metanotum shining black or brownish red; legs not as in *pilosellus* 16
    Metanotum brown with greyish pollen; legs yellow with all femora, front tibiae and apices of mid and hind tibiae pale brownish yellow ..... *pilosellus* Loew
16. Metanotum with brownish red; abdomen opaque brown with posterior angles and borders of segments ashy (St. Vincent Island) .... *indecisus* Will.
    Metanotum with shining black; abdomen shining with basal two-thirds of each segment black ..... *marginellus* Mall.

17. Legs wholly black or if not then legs brown with body wholly black.....18
Legs not black.....19
18. Large dark species; length 6 mm. (Alaska).....*alaskensis* Mall.
Small dark species; length 2 to 2.75 mm. (New York).....*arietinus* Coq.
19. General aspect blackish; halteres pale fuscous; legs sordid yellowish brown; tibiae long haired; thorax dark; abdomen shining and fuscous haired; R–M crossvein near middle of the wing (Greenland)..*tibialis* Staeger
Not as above.....20
20. Halteres luteous.....21
Halteres white.....24
21. Base of tibia brown; posterior margins of abdominal segments conspicuously yellow; length 2.5 mm.....*florens* Joh.
Base of tibia not darkened; posterior margins of abdominal segments not conspicuously yellow; length 3 mm. or more.....22
22. R_{2+3} absent.....*tenebrosus* Coq.
R_{2+3} present.....23
23. R–M crossvein not blackened; length 3 to 3.5 mm.....*inconspicuus* Mall.
R–M crossvein very distinctly blackened; length 3.5 to 4 mm..*hirtipennis* Loew.
24. Legs pale fuscous, the extreme tips of tibiae darker.....*fastuosus* Joh.
Legs entirely yellow.....*decoloratus* Mall.
25. Legs nearly uniform in color.....26
Legs distinctly bicolored.....32
26. Wings uniformly spotted with fuscous or if not then with only faint indication of darker bands.....27
Wings not spotted but with one or more conspicuous dark bands.....28
27. Wings uniformly spotted with fuscous.....*pictipennis* Zett.
Wings with only faint indication of darker bands.....*miripes* Coq.
28. First wing fascia lies beyond the crossvein; length 2.5 to 4 mm..*bifasciatus* Coq.
First wing fascia lies before or over the crossvein.....29
29. Abdomen of male transparent whitish with a broad brown posterior margin on each segment and a blackish brown interrupted longitudinal dorsal stripe.....*fulilus* V.d.Wulp
Abdomen of male otherwise marked.....30
30. Wing with only one conspicuous sinuous crossband.....*sinuosus* Coq.
Wing with two or three conspicuous sinuous crossbands.....31
31. Dorsum of thorax with three longitudinal reddish or buff stripes; abdomen pale yellow, the segments spotted or banded on anterior margins; wing with two prominent bands.....*carneus* Fab.
Dorsum of thorax unicolorous; abdomen with three terminal segments uniformly darkened; all three bands of wing distinct.....*fragilis* Walley
32. Wings spotted but not banded.....33
Wings with one or more cross bands.....33
33. Femora and sometimes tibiae also with dark bands.....35
Femora and tibiae not banded or with only apices of femora and either bases or apices of tibiae slightly darkened.....34
34. Wing with one broad median brownish band.....*algens* Coq.
Wing with two cross bands and the apex largely brown, these bands containing hyaline spots; apices of femora and tibiae slightly darkened; (New Hampshire); length 3 mm.....*discolor* Coq.
35. Legs yellowish banded as follows: all femora, tibiae and basitarsi with apical black bands, second tarsal joint pale throughout, remainder of tarsi black.....*apicalis* Walley
Legs pale, either base or apex of femora and tibiae and sometimes apical tarsal joint brown but never with apical three tarsal joints black.....36
36. Wing with irregular median band and apical third brownish marked with several hyaline spots; each femur with subapical ring; tibia with basal ring; length 3 to 4 mm.....*dyari* Coq.
Apex of wings with band or spot but no hyaline spots in it.....37

37. Length 3 to 3.5 mm.; thoracic stripes not margined with black; wings yellow, humeral crossvein brown clouded; brown fascia across wing and at apex of R_1; each femur with apical and tibia with basal brown band; tarsi white with apical joint brown; front metatarsus two-thirds as long as tibia; (New Jersey)..... *johnsoni* Coq.
Length 3 to 5 mm.; thoracic stripes margined with black; tibia without basal brown band; front metatarsus slightly shorter than tibia..... *ornatus* Meig.
38. Wings densely clothed with hairs, the costal margin yellowish tinged (Greenland)..... *pulchripennis* Lundb.
Wings spotted but with the costal margin not yellowish tinged.....39
39. Tibia with three dark bands.....43
Tibia one or two dark bands.....40
40. Femur with two brownish rings near the apex (California and New Mexico)..... *venustus* Coq.
Femur with at most one brownish ring near apex.....41
41. Anterior femora darkened (not annulate) inwardly and towards apex, also suffused with brown at base (British Columbia)..... *garretti* Walley
All femora with distinct brown ring before or at apices.....42
42. Length 5 mm.; abdomen of male pale yellow, black and brown fasciate; wing with apex from slightly before tip of R_1 grayish brown and containing several whitish hyaline drops (Washington)..... *guttularis* Coq.
Length 3 to 4 mm.; abdomen brownish fasciate; wing with apical half with many mostly isolated brown spots (New Mexico)..... *barberi* Coq.
43. Middle band on tibia equidistant or nearly so from apical and sub-basal bands.....44
Middle band on tibia located quite near apical band..... *monilis* Linn.
44. Second and third abdominal segments entirely pale or at least much paler than remaining segments.....45
Second and third abdominal segments darkened similarly to remaining segments, each with apical fourth white; legs pale, sub-basal band of femora faint or absent..... *prudens* Walley
45. Basal section of genital claspers of male more or less bulbous at base.....48
Basal section of genital claspers of male not bulbous at base.....46
46. Sub-basal black band on fore tibia broader than the two following bands and extending very close to base of tibia in front so that basal white band is about one-fourth as broad as black band..... *illinoensis* Mall.
Black bands on fore tibia equal in width; sub-basal black band and basal white band equal in width and quite narrow.....47
47. Middle band on tibia noticeably beyond middle of distance between sub-basal and apical bands; abdomen with segments two to five with rather elongate dirty brown vittae on either side..... *mallochi* Walley
Middle band on tibia not noticeably beyond middle of distance between sub-basal and apical bands; abdomen not as above but with basal segments uniformly pale or slightly darkened..... *peleensis* Walley
48. Genital claspers with small bulge at base; wings with five blackish spots on the anal region..... *idei* Walley
Genital claspers with very large bulge at base on the outer side; wings with spots forming three irregular blackish fasciae..... *basalis* Walley

Notes on the Canadian Species of Tanypus.

Tanypus currani Walley.

(Fig. 14).

Tanypus currani Walley, Can. Ent., LVII, 276, 1925.

Described from Aylmer, Que. and Ottawa, Ont. Additional specimens have been taken in the same localities by the writer.

Tanypus melanops Meigen.

Tanypus melanops Meig., Syst. Beschr., 1: 65, 18, 1818.
Tanypus bicolor Fries., Monogr. Tanyp. Suec., 17, 12, 1823.
Tanypus unicolor Walker, List. Dipt. Brit. Mus., 1: 19, 1848.

Length 4.5 mm. Generally pale throughout. Thorax creamy yellow often with indications of indistinct darker yellow but never vittate. Scutellum and halteres white; postnotum yellowish. Legs pale yellowish white, tarsal tips darkened. Wings hyaline. Abdomen pale; segments 1 and 2 entirely so; 3, 4, 5 and 6 suffused with a fuscous sub-basal band; 7 fuscous except at apex.

Recorded as follows: New York, New Jersey, Michigan and Nebraska (Johannsen); Indiana, Illinois and Wisconsin (Malloch). Specimens have been examined from the following Canadian localities: Quebec—Aylmer, 14 ♂ Aug. 1, 1925 (Curran), Ontario—Ottawa 14 ♂ July 31, 1924, ♀ Aug. 8, 1925 (Curran and Walley); Cornwall 2 ♂ June 27, 1925 (Ide); Queenston, ♂ July 28, 1925 (Walley); Niagara Falls, 2 ♂ July 30, 1925 (Walley); Normandale 8 ♂ July 9, 1925 (Walley); Point Pelee, 6 ♂ June 11 to July 14, 1925 (Walley).

This pale species is found commonly resting on foliage on the undersides of broad leaves. It has been taken throughout the summer in many of the same localities as *T. monilis* Linn.

Tanypus senatus Walley.
(Fig. 13).

Tanypus senatus Walley, Can. Ent. LVII, 276, 1925.

This species is known only from the single male type specimen collected at Ottawa, Ont., Aug. 18, 1924 (Walley). It is a pale species belonging to the *melanops-pilicaudatus* group of species. It differs from *melanops* in shape of male genitalia, lacks the tarsal tuft of hairs of *currani* and does not have special clusters of pile on the eighth tergite as in *pilicaudatus* and *cornuticaudatus*.

Tanypus cornuticaudatus Walley.

Tanypus cornuticaudatus Walley, Can. Ent., LVII, 277, 1925.

The horn-like cluster of golden brownish hairs on each side the eighth tergite of the male will at once distinguish this species from other species of *Tanypus*. In addition to the specimens recorded in the type series from Ottawa Golf Club, Que., and

Ottawa, Ont., a male specimen is at hand from Chatham, Ont., May 22, 1925 (Walley).

Tanypus pilicaudatus Walley.

Tanypus pilicaudatus Walley, Can. Ent., LVII, 277, 1925.

The two dense clusters of recurved pile on the eighth tergite of the male distinguish *pilicaudatus* from all other species of *Tanypus*. In addition to the type series from Ottawa, Ont., and Hull, Que., the following records are at hand: Quebec—Coteau du lac, ♂ June 25, 1925 (Ide); Lachine, ♂ June 29, 1925 (Petch); Ontario—Normandale, 12 ♂, 2 ♀, July 8, 1925 (Walley); Fisher's Glen, 2 ♂ July 2, 1925 (Walley); Point Pelee, 9 ♂, 6 ♀ June 5—July 10, 1925 (Walley).

This species was discovered resting on the leaves of low shrubs and herbaceous plants.

Tanypus apicalis Walley.

Tanypus apicalis Walley, Can. Ent., LVIII, 64, 1926.

Wings banded somewhat as in *T. carneus* L. (Fig. 11) but distinct from *T. carneus* in having all femora, tibiæ and basitarsi with apical black bands.

Known only from the type series from Aylmer, Que., and Norway Point, Lake of Bays, Ont.

Tanypus hirtipennis Loew.

(Fig. 6).

Tanypus hirtipennis Loew, Berl. Ent. Zeit., (Centur. VII) 5, 1866.

Described from the female sex from Maine. Recorded from New York (Cornell Univ. Agric. Exp. Sta., Mem. 101, p. 709, 1928), Illinois (Malloch) and Quebec (Fyles). The writer has determined one female from Point Pelee, Ont., June 11, 1925 (Walley) and a female from Aweme, Man., May 21, 1922 (Robertson).

This species is easily separated from other species of *Tanypus* by the characters given in the key. Malloch presents a good description of both sexes. In wing characters this species appears to be intermediate in position between the wholly pale and immaculate type as in *T. senatus* (Fig. 13) and the dark and spotted type as in *T. dyari* (Fig. 5).

Tanypus dyari Coquillett.
(Fig. 5).

Tanypus dyari Coquillett, Ent. News, XIII, 85, 1902.
Ablabesmyia dyari Johannsen, N. Y. St. Mus. Bul., 86, 146, 1905.
Tanypus dyari Malloch, Bul. Ill. St. Lab. Nat. Hist., X, Art. 6, 379, 1915.

Distinguishable from other species of *Tanypus* by the characters given in the preceding key. Specimens examined by the writer agree with Johannsen's and Malloch's descriptions. The wings are characteristic in having the four rounded clear areas within the area of the dark preapical band.

The species is recorded as follows: Massachusetts, Pennsylvania, New York, District of Columbia, Michigan, South Dakato (Johannsen); Illinois (Malloch); Idaho, Washington (Aldrich). Canadian material is at hand as follows: Ontario—Ottawa, ♀ Aug. 27, 1906 (no collector given); Manitoba—Carroll, 4 ♂ Aug. 23, 1922 (Criddle).

Malloch records capturing the imago in late October and one specimen December 2nd which he believes to have been hibernating as an imago. Miss Mitchell records finding the larvæ in March so that it is probable that the species winters in the larval stage. Most of the captures of imagos were made in late summer and autumn and it seems more probable that the specimen taken on December 2nd was merely a straggler from a late fall brood.

Tanypus garretti Walley.

Tanypus garretti Walley, Can. Ent., LVII, 275, 1925.

Described and known only from the five type specimens, Oliver, B. C., June 26, 1923 (Garrett).

The narrowed elongate basal section of the male genital forcep (Can. Ent. LVII, 274, Fig. 4) will distinguish this species from other species of *Tanypus*. The wing is maculate but not banded as in *dyari*.

Tanypus monilis Linnaeus.
(Fig. 3).

Tipula monilis Linn., Syst. Nat., ed. 10, 578, 1758.
Tipula maculatus Degeer, Mem. l'hist. Ins., 6: 394, 1776.
Tanypus annulatus Say, Journ. Acad. Nat. Sci., Phil., 3: 15, 1823.

Tanypus monilis may be distinguished from other species of *Tanypus* by having spotted wings and the tibiæ with three distinct brownish bands, the middle band distinctly nearer the apical than the basal dark band. The wings are heavily spotted

with brown, the spots almost forming bands, the crossveins are darkened and there are three small tufts of dark hair on the costal margin.

Johannsen records *T. monilis* from New Jersey, New York, Illinois and South Dakota. Malloch records specimens from the Illinois river and associated waters having found it in both larval and pupal stages. In Canada specimens have been examined from the following localities: Quebec—Coteau du lac, 4 ♂, ♀ June 25, 1925 (Ide); Aylmer, 2 ♂, 6 ♀ July 27-31, 1923 (Curran); Ontario—Prescott, ♂, ♀ June 30, 1925 (Ide); Trenton, 8 ♀ June 26—Sept. 3, 1911 (Evans); Point Pelee, 44 ♂, 9 ♀ June 11—July 21, 1925 (Walley); Orillia, 5 ♂, ♀ July 21, 1923 (Curran).

The writer has observed large numbers of adults of both sexes at Pt. Pelee, Ont., in the vicinity of a large marsh and pond area. The adults were found in large numbers on the trunks of trees the color of the bark of which they closely resemble. In the daytime the adults remained motionless but in the evening and until dusk they were observed to swarm.

Tanypus prudens Walley.
(Fig. 1).

Tanypus prudens Walley, Can. Ent., LVII, 275, 1925.

Known only from the type series from Aylmer, Que., Delta and Aweme, Man. Distinct from other species by the characters mentioned in the preceding key. The wings have the crossvein darkened and are spotted but not distinctly banded.

Tanypus illinoensis Malloch.
(Fig. 2).

Tanypus illinoensis Malloch, Bul. Ill. St. Lab. Nat. Hist., X, Art. 6, 376, 1915.

Described from Illinois and subsequently recorded from New York (Cornell Univ. Agric. Exp. Sta., Mem. 101, p. 709, 1928). A series of 35 ♂, 7 ♀ taken by the writer at Point Pelee, Ont., June 3—July 21, 1925 agree with paratypes of this species.

Tanypus mallochi Walley.
(Fig. 8).

Tanypus mallochi Walley, Can. Ent., LVII, 273, 1925.

Described from Ottawa, Ont., and Aylmer, Que., and subsequently recorded from the same localities and from Kirk's Ferry, Que. 8 ♂ Aug. 4, 1925 (Walley).

The Kirk's Ferry specimens were taken swarming in large numbers close to the bank of the Gatineau river in late afternoon. The type specimens were found resting on the trunks of trees.

Tanypus peleensis Walley.
(Fig. 9).

Tanypus peleensis Walley, Can. Ent., LVIII, 64, 1926.

This species has been recorded so far only from Point Pelee, Ont. It was found by the writer to occur there in large numbers and was taken on various dates during the months of June and July, 1925 and again by Mr. Ide in 1927. The 74 specimens included in the type series represent only a small fraction of those which might have been captured. This species and *T. monilis* were the two commonest species of *Tanypus* in the Point Pelee region.

The adults of both sexes were found resting on the trunks of trees and in the afternoon and toward evening were observed to swarm. On some days this species was found in large numbers, several hundred individuals on a single tree trunk. During most of the day they rested quietly clinging close to the bark and not flying unless disturbed. Specimens were also found on the screens and walls of dwellings in the vicinity of trees. Very rarely were any specimens found on foliage.

Tanypus idei Walley.
(Fig. 4).

Tanypus idei Walley, Can. Ent., LVII, 272, 1925.

Known only from the single male type specimen collected at Ottawa, Ont., Aug. 1, 1924 (Ide).

The species *idei*, *illinoensis*, *mallochi* and *peleensis* appear to be closely related and superficially quite similar. The number and position of the wing spots have proved useful characters for the separation of these four species.

In *idei* the subapical spot between M and Cu_1 is small and fused with the large quadrate spot between R_{4+5} and M. The spot at the apex of Cu_1 is very faint.

In *illinoensis* the subapical spot between M and Cu_1 is directly posterior to the spot between R_{4+5} and M. The spot at the apex of Cu_1 is distinct.

In *mallochi* the subapical spot between M and Cu_1 is nearer the apex of the wing than the spot between R_{4+5} and M. The spot at the apex of Cu_1 is small.

In *peleensis* the subapical spot between M and Cu_1 is nearer the base of the wing than the spot between R_{4+5} and M. The spot at the apex of Cu_1 is distinct.

Tanypus basalis Walley.

Tanypus basalis Walley, Can. Ent., LVII, 273, 1925.

Described from two male specimens from Ottawa, Ont., and Aylmer, Que. The writer has also studied material from Point Pelee, Ont. 25 ♂, 6 ♀, June 10-20, 1925 (Walley); Normandale, Ont. 2 ♂ July 9, 1925 (Walley).

Tanypus alaskensis Malloch.

(Fig. 7).

Tanypus alaskensis Malloch, Rept. Can. Arct. Expdn. III, Pt. c, 35, 1919.

A rather large dark species with legs uniformly brown, wings sparsely hairy and with crossvein darkened. Abdomen dark brown with a trace of grey pollen at the apices of the first four or five segments. Basal section of male genital clasper somewhat as in *T. senatus* (Can. Ent., LVII, 274, 1925, Fig. 7) but slightly longer, narrower and more angulate at apex. Apical arm of clasper stout, strongly angulate close to base, more so than in *T. currani* (Can. Ent., LVII, 274, 1925, Fig. 6) from thence straight terminating in a blunt point.

Recorded only from Alaska (Can. Arct. Expdn.) but probably also occurring in northern Canada.

Tanypus algens Coquillett.

(Fig. 12).

Tanypus algens Coquillett, Proc. U. S. Nat. Mus., 25: 90, 1902.

Described from a single female taken at Popoff Island, Alaska, 1902. The writer has determined one female specimen from Banff, Alta., July 19, 1922 (Garrett). This appears to be the only Canadian record for this species.

Tanypus carneus Fabricius.

(Fig. 11).

Chironomus carneus Fabricius, Syst. Ant., 41, 16, 1805.

Recorded from New York (Johannsen), Illinois (Malloch), and New Jersey. The following Canadian localities are repre-

sented in material examined by the writer: Nova Scotia—Kentville, ♀ June 6, 1923 (Gorham); Quebec—Coteau du lac, 3 ♂ June 25, 1925 (Ide); Chateguay, ♂ June 18, 1925 (Ide); Ontario—Ottawa, ♀ June 3, 1923 (Curran); Cornwall, ♂ June 27, 1925 (Ide); Niagara Falls, ♀ July 30, 1925 (Walley); Point Pelee, 10 ♂, 3 ♀ June 17—July 24, 1925 (Walley).

Tanypus fragilis Walley.
(Fig. 10).

Tanypus fragilis Walley, Can. Ent., LVIII, 205, 1926.

Known only from the holotype; Ingersoll, Ont., Sept. 8, 1924 (F. G. Walley). The three banded wing makes this species an easily recognizable one.

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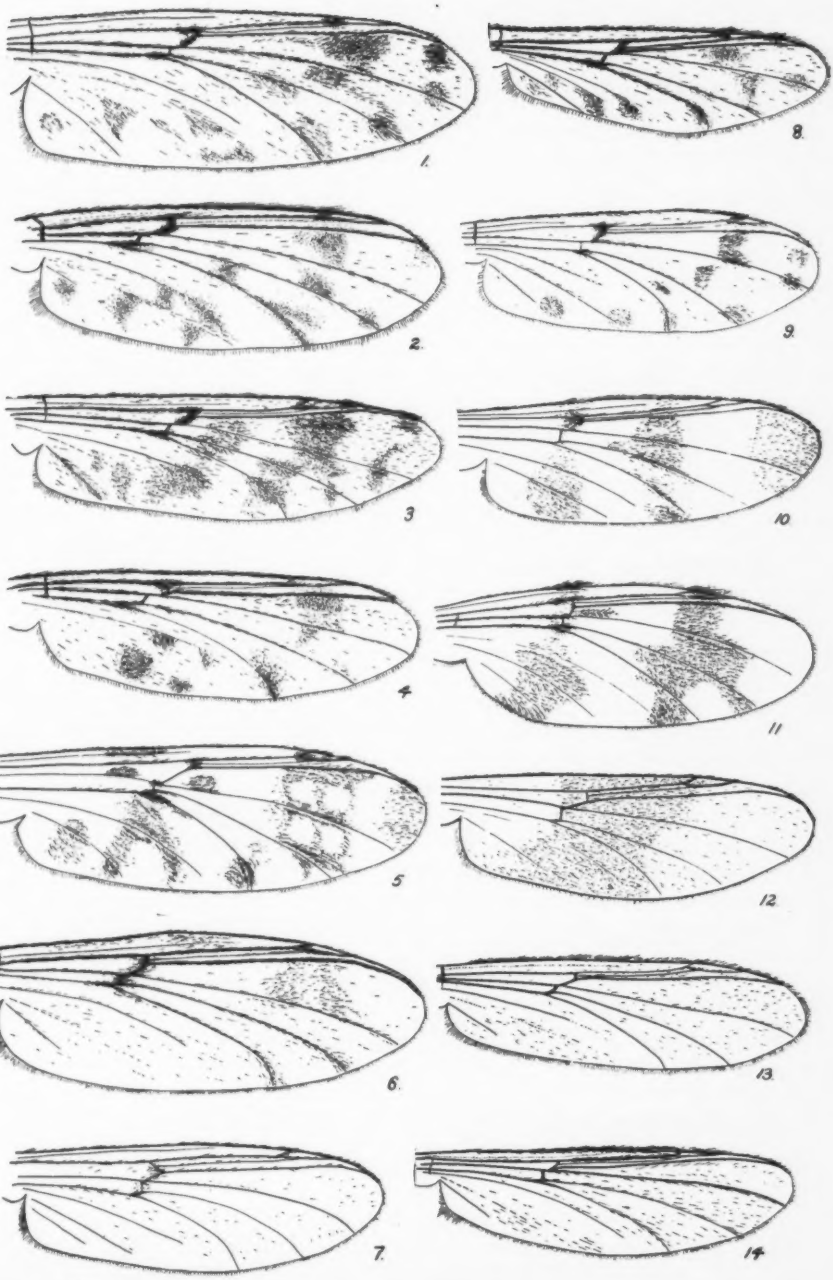
EXPLANATION OF PLATE XXXII.

WINGS OF CANADIAN SPECIES OF TANYPUS.

Fig. 1. *T. prudens.*
Fig. 2. *T. illinoensis.*
Fig. 3. *T. monilis.*
Fig. 4. *T. idei.*
Fig. 5. *T. dyari.*
Fig. 6. *T. hirtipennis.*
Fig. 7. *T. alaskensis.*
Fig. 8. *T. mallochi.*
Fig. 9. *T. peleensis.*
Fig. 10. *T. fragilis.*
Fig. 11. *T. carneus.*
Fig. 12. *T. algens.*
Fig. 13. *T. senatus.*
Fig. 14. *T. currani.*



G. Stuart Walley.

NOTES ON INSECTS INHABITING THE ROOTS OF WEEDS.

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The importance of knowing where immature insects develop is very evident to entomologists. The prevalence of weeds in and near cultivated fields and the danger of the wood-infesting insects attacking our crops is appreciated by the economic worker. This knowledge is also important to the taxonomist and ecologist. The amount of information that has accumulated regarding the insects upon the aerial portions of weeds seems quite extensive when compared with the scarcity of facts recorded about the root inhabitants.

The data reported in this paper were secured at Ames, Iowa, during the summer months. Grasses, Gramineæ, were included in the early part of the investigation only. Growing plants were dug up, the aerial portions cut off, and all soil removed from the roots by shaking or washing as necessity demanded. The roots were placed in wooden boxes containing glass emergence tubes to await the coming forth of the inhabitants. Coarse sand, after being dried to and exposed to direct sunlight for several weeks, was used to cover the roots in some instances to better retain the moisture. A few roots were potted in soil but this proved unsatisfactory because of the danger of late infestation. Water was added when necessary to prevent the roots from drying.

No attempt is made in this paper to distinguish the parasitic and predaceous forms from the true root feeders. While only growing plants were used some of the insects feeding upon the roots do not normally attack the growing tissue. Dead or decaying areas on some of the roots may have been a result of the feeding of the larvæ or the condition conducive to the initial attack. The results enlarge the number of known host plants for some insects, include records of infestation of the roots of several plants of which formerly the aerial parts only were known to be attacked, and in a few cases give the first records of the host plants for both genus and species. About

seventy-five different insects in seven orders (Collembola, Corrodentia, Homoptera, Coleoptera, Lepidoptera, Hymenoptera, and Diptera) were collected. Forty-eight have been determined to species and twenty to genus only. Most of the latter are parasitic or predaceous forms.

INSECT LIST.

COLLEMBOLA.

LEPIDOCYRTUS Sp. Det. J. W. Folsom. *Helianthus tuberosus* L.

CORRODENTIA.

PSOCIDÆ.

CAECILIUS IMPACTUS Aaron. Det. A. N. Caudell. *Helianthus tuberosus* L.

HOMOPTERA.

APHIDIDÆ.

ANURAPHIS MIDDLETONI Thomas. Det. E. M. Patch. (According to Guyton), *Taraxacum officinale* Weber.

APHIS MAIDI-RADICIS Forbes. *Digitaria sanguinalis* (L). Scop. (Associated with Formicinæ). *Panicum capillare* L. (One case was associated with both *Solenopsis molesta* Say and *Lasius niger* var. *neoniger* Emery. Det. M. R. Smith). *Echinochloa crusgali* (L) Beauv. (Associated with Formicinæ). *Setaria viridis* (L.) Beauv. (Associated with Formicinæ). *Polygonum hydropiper* L. *Chenopodium album* L. (A few cases associated with *Lasius niger* var. *neoniger* Emery. Det. M. R. Smith). *Amaranthus retroflexus* L. *Portulaca oleracea* L. (Aphids det. E. M. Patch). (A few cases associated with *Lasius niger* var. *neoniger* Emery. Det. M. R. Smith). *Plantago major* L. *Erigeron canadensis* L. (A few cases associated with *Solenopsis molesta* Say and *Lasius niger* var. *neoniger* Emery. Det. M. R. Smith). *Ambrosia artemisiifolia* L. (Associated with *Lasius niger* var. *neoniger* Emery. Det. M. R. Smith). *Anthemis cotula* L. *Arctium lappa* L. (Associated with *Lasius niger* var. *neoniger* Emery. Det. M. R. Smith).

HYSTERONEURA SETARIÆ Thomas. Det. C. P. Gillette and M. A. Palmer. *Setaria glauca* (L.) Beauv.

ANOECIA QUERCI Fitch. Det. E. M. Patch. *Setaria glauca* (L.) Beauv. (Associated with Formicinæ). *Oenothera biennis* L.

ANOECIA OENOTHERÆ Wilson. Det. E. M. Patch. *Oenothera biennis* L.

PEMPHIGUS LACTUCÆ Fitch. Det. E. M. Patch, (According to Cutright). *Rumex crispus* L. *Polygonum pennsylvanicum* L. *Capsella bursa-pastoris* (L.) Medic.

PEMPHIGUS Sp. Det. F. C. Hottes. *Amaranthus retroflexus* L.

PEMPHIGINÆ. Largely det. F. C. Hottes. *Rumex altissimus* Wood. *Polygonum persicaria* L. *Agrimonia striata* Michx. (A few cases associated with *Lasius niger* var. *americana* Emery. Det. M. R. Smith). *Prunella vulgaris* L. *Plantago major* L. *Solidago canadensis* L. *Ambrosia trifida* L. (One case associated with *Lasius umbratus mixtus* var. *aphidicola* Walsh. Det. M. R. Smith). *Arctium lappa* L. *Taraxacum officinale* Weber. (In one case associated with mealy bug, *Trionymus trifolii* Forbes and *Lasius niger* var. *americana* Emery. *L. niger* carried both species when plant was disturbed). *Compositæ*. (In one case associated with *Crematogaster* Sp. Det. M. R. Smith).

COCCIDÆ.

TRIONYMUS TRIFOLII Forbes. Det. G. F. Ferris. *Taraxacum officinale* Weber. (In one case associated with an Aphid, Pemphiginæ, and *Lasius niger* var. *americana* Emery).

PSEUDOCOCCUS Sp. Det. G. F. Ferris. *Ambrosia artemisiifolia* L. (?) *Cannabis sativa* L.

COLEOPTERA.

CHRYSOMELIDÆ.

DIABROTICA DUODECIMPUNCTATA Fabr. *Amaranthus retroflexus* L. (Larva feeding on roots. Plant in squash field).

MORDELLIDÆ.

MORDELLISTENA SERICANS Fall. Det. E. Liljeblad. *Amaranthus graecizans* L.

CURCULIONIDÆ.

APION IMPUNCTISTRIATUM Smith. Det. L. L. Buchanan. *Ambrosia trifida* L.
LIXUS CONCAVUS Say. *Rumex crispus* L.
BARIS Sp. (2–3 species). Det. H. S. Barber. *Polygonum pennsylvanicum* L. *Ambrosia artemisiifolia* L. *Xanthium canadense* Mill. *Cirsium canescens* Nutt. *Cirsium lanceolatum* (L.) Hill.
RHINONCUS PYRRHOPUS Lec. Det. H. S. Barber. *Polygonum pennsylvanicum* L.
CONOTRACHELUS NIVOSUS Lec. Det. H. S. Barber. *Amaranthus retroflexus* L. *Amaranthus graecizans* L.
CONOTRACHELUS SENICULUS Lec. Det. H. S. Barber. *Amaranthus retroflexus* L. *Amaranthus graecizans* L. (One dealated ♀ of *Ponera coarctata* subsp. *pennsylvanica* Buckley recovered from roots containing larvæ of Conotrachelus. Det. M. R. Smith).
TYLODERMA AEREA Say. Det. H. S. Barber. *Oenothera biennis* L. *Labiatæ*. *Xanthium canadense* Mill. *Helianthus tuberosus* L.
TYLODERMA FOVEOLATA Say. Det. H. S. Barber. *Oenothera biennis* L. *Helianthus tuberosus* L.
RHODABAENUS TREDECIMPUNCTATUS Illiger. Det. H. S. Barber. *Xanthium canadense* Mill. (Mites, *Macrocheles*, numerous on several specimens at time of emergence while Diptera emerging at the same time were not infested. Det. H. E. Ewing).

LEPIDOPTERA.

OLETHREUTIDÆ.

OLETHREUTES NUBILANA Clem. Det. C. Heinrich. Labiatæ. (Feeding on underground stem).

TORTRICIDÆ.

EUCOSMA ROBINSONANA Grote. Det. C. Heinrich. *Erigeron canadensis* L.

NOCTUIDÆ.

PAPAIPEMA NITELLA Gn. *Ambrosia trifida* L. *Xanthium canadense* Mill. Det. H. G. Dyar.

HYMENOPTERA.

VIPIONIDÆ.

OPIUS Sp. Det. A. B. Gahan. *Oenothera biennis* L.

ALYSIIDÆ.

Dacnusa Sp. Det. A. B. Gahan. *Lobelia siphilitica* L.

BRACONIDÆ.

CHELONUS Sp. near cautus Cress. Det. R. A. Cushman. *Erigeron Canadensis* L.
DIOSPILUS Sp. Det. A. B. Gahan. *Portulaca Oleracea* L.

FIGITIDÆ.

EUCOILA (Heptamerocera) Sp. Det. L. H. Weld. *Ambrosia trifida* L.
EUCOILA (Rhoptromeris) Sp. Det. L. H. Weld. *Xanthium canadense* Mill.

CYNIPIDÆ.

CYNIPIDÆ Sp. Det. A. B. Gahan. *Amaranthus retroflexus* L. *Ambrosia trifida* L. *Xanthium canadense* Mill.

TETRASTICHIDIDÆ.

TETRASTICHUS Sp. Det. A. B. Gahan. *Erigeron canadensis* L.

EULOPHIDÆ.

EULOPHID Sp. Det. A. B. Gahan. *Cirsium lanceolatum* (L.) Hill.

CHALCIDIDÆ.

ANAPHOIDEA SORDIDATA Cir. Det. A. B. Gahan. *Oenothera biennis* L. (Two specimens from different plants containing *Tyloerma aerea* and *T. foveolata*).

PLATYGASTRIDÆ.

LEPTACIS Sp. Det. A. B. Gahan. *Stachys palustris* L. *Ambrosia artemisiifolia* L.

DIPTERA.

CHIRONOMIDÆ.

FORCIPOMYIA CILIPES Coq. Det. O. A. Johannsen. *Helianthus tuberosus* L.
FORCIPOMYIA Sp. ♀ near pilosa Coq. (Undescribed). Det. O. A. Johannsen. *Amaranthus retroflexus* L.

MYCETOPHILIDÆ.

NEOSCIARA CELLARIS Comb. Det. C. Garrett. *Cirsium laneolatum* (L.) Hill. *Chenopodium album* L.
NEOSCIARA CELLARIS (near) Comb. Det. C. Garrett. *Helianthus tuberosus* L. *Cirsium lanceolatum* (L.) Hill.
NEOSCIARA COPROPHYLA Lint. Det. C. Garrett. *Amaranthus retroflexus* L. *Xanthium canadense* Mill.
NEOSCIARA CUCUMERIS Johan. Det. C. Garrett. *Xanthium canadense* Mill. *Cirsium lanceolatum* (L.) Hill.
NEOSCIARA SATIVÆ Johan. Det. C. Garrett. *Xanthium canadense* Mill. *Cirsium lanceolatum* (L.) Hill.
LEIA BIVITTATA Say. Det. J. M. Aldrich. *Erigeron canadensis* L.
LEIA OBLECTABILIS Liv. Det. J. M. Aldrich. *Amaranthus retroflexus* L. *Xanthium canadense* Mill.

CECIDOMYIIDÆ.

CAMPYLOMYZA Sp. Det. E. P. Felt. *Portulaca oleracea* L.
JOANNISIA Sp. Det. E. P. Felt. *Amaranthus retroflexus* L. *Portulaca oleracea* L. *Erigeron canadensis* L. *Xanthium canadense* Mill.
LESTODIPLOSIS (?) Sp. Det. E. P. Felt. *Amaranthus retroflexus* L. *Erigeron canadensis* L. *Ambrosia artemisiifolia* L. *Xanthium canadense* Mill. *Helianthus tuberosus* L.
LASIOPTERA Sp. Det. E. P. Felt. *Erigeron canadensis* L.
ITONIDIDINARIÆ. *Cirsium lanceolatum* (L.) Hill.

SCATOPSIDÆ.

SWAMMERDAMELLA BREVICORNIS Mq. Det. J. M. Aldrich. *Amaranthus retroflexus* L. *Xanthium canadense* Mill.

EMPIDIDÆ.

PLATYPALPUS CRASSIFEMORIS Fitch. Det. J. M. Aldrich. *Portulaca oleracea* L.
DRAPETIS Sp. Det. J. M. Aldrich. *Sonchus oleraceus* L.

PHORIDÆ.

APIOCHAETA Sp. Det. J. M. Aldrich. *Chenopodium album* L. *Cirsium canescens* Nutt.

BORBORIDÆ.

LEPTOCERA FONTINALLIS Fall. *Xanthium canadense* Mill.
SCOTOPHILELLA EVANESCENS Tuck. *Xanthium canadense* Mill.

LONCHAEIDÆ.

LONCHAEA POLITA Say. Det. J. M. Aldrich. *Amaranthus graecizans* L. *Taraxacum officinale* Weber. (Plant dying).

CHLOROPIDÆ.

OSCINELLA COXENDIX Fitch. Det. J. M. Aldrich. *Amaranthus retroflexus* L. *Amaranthus blitoides* Wats. *Oenothera biennis* L. *Ambrosia artemisiifolia* L. *Ambrosia trifida* L. *Xanthium canadense* Mill. *Helianthus tuberosus* L. *Taraxacum officinale* Weber. (Plant dying).

OSCINELLA DORSALIS L. Det. J. M. Aldrich. *Taraxacum officinale* Weber. (Plant dying).

OSCINELLA MELANCHOLICA Beck. Det. J. M. Aldrich. *Amaranthus retroflexus* L. *Monarda fistulosa* L. *Xanthium canadense* Mill.

OSCINELLA FRIT L. Det. J. M. Aldrich. *Amaranthus retroflexus* L.

ELACHIPTERA COSTATA Lw. Det. J. M. Aldrich. *Amaranthus retroflexus* L. *Ambrosia trifida* L. *Xanthium canadense* Mill.

SIPHONELLA FINALIS Beck. Det. J. M. Aldrich. *Amaranthus retroflexus* L. *Ambrosia Trifida* L.

MELANOCHAETA LONGULA Lw. Det. J. M. Aldrich. *Amaranthus retroflexus* L.

DROSOPHILIDÆ.

DROSOPHILA FUNEBRIS Fall. Det. J. M. Aldrich. *Amaranthus retroflexus* L.

DROSOPHILA QUINARIA Lw. Det. J. M. Aldrich. *Xanthium canadense* Mill.

AGROMYZIDÆ.

AGROMYZA MACULOSA Mall. Det. J. M. Aldrich. *Amaranthus graecizans* L.

AGROMYZA VIRENS Lw. Det. J. M. Aldrich. *Verbena stricta* Vent. *Verbena bracteosa* Michx. *Lobelia siphilitica* L. *Ambrosia artemisiifolia* L.

AGROMYZA ABNORMALIS Mall. Det. J. M. Aldrich. *Amaranthus* retroflexus L.

ANTHOMYIIDÆ.

HYLEMYIA CILICRURA Rdi. Det. J. M. Aldrich. *Rumex altissimus* Wood. *Chenopodium album* L. *Lappula echinata* Gilibert. *Xanthium canadense* Mill. *Taraxacum officinale* Weber. *Lactuca scariola* L.

MUSCIDÆ.

Stomoxys calcitrans L. Det. J. M. Aldrich. *Malva rotundifolia* L.

PLANT LIST.

GRAMINEÆ.

DIGITARIA SANGUINALIS (L.) Scop. *Aphis maidi-radicis* Forbes. (Associated with Formicinæ).

PANICUM CAPILLARE L. *Aphis maidi-radicis* Forbes. (One case was associated with both *Solenopsis molesta* Say and *Lasius niger* var. *neoniger* Emery).

ECHINOCHLOA CRUSGALI (L.) Beauv. *Aphis maidi-radicis*. (Associated with Formicinæ).

SETARIA VIRIDIS (L.) Beauv. *Aphis maidi-radicis*. (Associated with Formicinæ).

SETARIA GLAUCA (L.) Beauv. *Hysteroneura setariæ* Thomas. *Anoecia querci* Fitch. (Associated with Formicinæ).

URTICACEÆ.

CANNIBIS SATIVA L. Mealy bug.

POLYGONACEÆ.

RUMEX CRISPUS L. *Pemphigus lactucæ* Fitch. *Lixus concavus* Say.

PEMPHIGINÆ. *Hylemyia cilicrura* Rdi.

RUMEX ALTISSIMUS Wood.

POLYGONUM PENNSYLVANICUM L. *Pemphigus lactucæ* Fitch. *Baris* Sp. *Rhinoncus pyrrhopus* Lec.

POLYGONUM PERSICARIA L. *Pemphiginæ*.

POLYGONUM HYDROPIPER L. *Aphismaidi-radicis* Forbes.

CHENOPODIACEÆ.

CHENOPODIUM ALBUM L. *Aphis maidi-radicis* Forbes. (A few cases associated with *Lasius niger* var. *Noeniger* Emery). *Neosciara cellaris* Comb. *Apiochaeta* Sp. *Hylemyia cilicrura* Rdi.

AMARANTHACEÆ.

AMARANTHUS RETROFLEXUS L. *Aphis maidi-radicis* Forbes. *Pemphigus* Sp. *Diabrotica duodecimpunctata* Fbr. (Larva feeding on roots. Plant in squash field). *Conotrachelus nivosus* Lec. *Conotrachelus seniculus* Lec. *Cynipidæ*. *Forcipomyia* Sp. ♀ near *pilosa* Coq. (Undescribed). *Neosciara coprophyla* Lint. *Leia oblectabilis* Lw. *Joannisia* Sp. *Lestodiplosis* (?) Sp. *Swammerdamella brevicornis* Mq. *Oscinella coxendix* Fitch. *Oscinella frit* L. *Oscinella melancholica* Beck. *Elachiptera costata* Lw. *Siphonella finalis* Beck. *Melanochaeta longula* Lw. *Drosophila funebris* Fall. *Agromyza abnormalis* Mall.

AMARANTHUS BLITOIDES Wats. *Oscinella coxendix* Fitch.

AMARANTHUS GRAECIZANS L. *Mordellistena sericans* Fall. *Conotrachelus nivosus* Lec. *Conotrachelus seniculus* Lec. (One dealated ♀ of *Ponera coarctata* subsp. *Pennsylvanica* Buckley recovered from roots containing larvæ of *conotrochelus*). *Lonchaea polita* Say. *Agromyza maculosa* Mall.

PORTULACACEÆ.

PORTULACA OLERACEA L. *Aphis maidi-radicis* Forbes. (A few cases associated with *Lasius niger* var. *neoniger* Emery). *Diospilus* Sp. *Campylomyza* Sp. *Joannisia* Sp. *Platypalpus crassifermoris* Fitch.

CRUCIFERÆ.

CAPSELLA BURSA-PASTORIS (L.) Medic. *Pemphigus lactucæ* Fitch.

ROSACEÆ.

AGRIMONIA STRIATA Michx. *Pemphiginæ*. (A few cases associated with *Lasius niger* var. *americana* Emery).

MALVACEÆ.

MALVA ROTUNDIFOLIA L. *Stomoxys calcitrans* L.

ONAGRACEÆ.

OENOTHERA BIENNIS L. *Anoecia oenotheræ* Wilson. *Anoecia querci* Fitch. *Tyloderma foveolata* Say. *Tyloderma aerea* Say. *Opius* Sp. *Anaphoidea sordidata* Gir. (Two specimens from different plants containing *Tyloderma aerea* and *T. foveolata*). *Oscinella coxendix* Fitch.

BORAGINACEÆ.

LAPPULA ECHINATA Gilibert. *Hylemyia cilicrura* Rdi.

VERBENACEÆ.

VERBENA STRICTA Vent. *Agromyza virens* Lw.

VERBENA BRACTEOSA Michx. *Agromyza virens* Lw.

LABIATÆ.

PRUNELLA VULGARIS L. *Pemphiginæ*.

STACHYS PALUSTRIS L. *Leptacis* Sp.

MONARDA FISTULOSA L. *Oscinella melancholica* Beck.

LABIATÆ (Underground stem). *Tyloderma aerea* Say. *Olethreutes nubilana* Clem.

PLANTAGINACEÆ.

PLANTAGO MAJOR L. *Aphis maidi-radicis* Forbes. *Pemphiginæ*.

LOBELIACEÆ.

LOBELIA SIPHILITICA L. *Dacnusa* Sp. *Agromyza virens* Lw.

COMPOSITÆ.

SOLIDAGO CANADENSIS L. Pemphiginæ.

ERIGERON CANADENSIS L. *Aphis maidi-radicis* Forbes. (A few cases associated with *Solenopsis molesta* Say and *Lasius niger* var. *neoniger* Emery). *Eucosma robinsonana* Grote. *Chelonus* Sp. *Tetrastichus* Sp. *Leia bivittata* Say. *Joannisia* Sp. *Lestodiplosis* (?) Sp. *Lasioptera* Sp.

AMBROSIA ARTEMISIIFOLIA L. *Aphis maidi-radicis* Forbes. (A few cases associated with *Lasius niger* var. *neoniger* Emery). *Pseudococcus* Sp. *Baris* Sp. *Leptacis* Sp. *Lestodiplosis* (?) Sp. *Oscinella coxendix* Fitch. *Agromyza virens* Lw.

AMBROSIA TRIFIDA L. Pemphiginæ. (One case associated with *Lasius umbratus mixtus* var. *aphidicola* Walsh). *Apion impunctistriatum* Smith. *Papaipema nitella* Gn. *Eucoila* (Heptamerocera) Sp. Cynipidæ. *Oscinella coxendix* Fitch. *Elachiptera costata* Lw. *Siphonella finalis* Beck.

XANTHIUM CANADENSE Mill. *Baris* Sp. *Tyloderma aerea* Say. *Rhodobaenus tredecimpunctatus* Illiger. *Papaipema nitella* Gn. *Eucoila* (Rhoptromeris) Sp. Cynipidæ. *Neosciara coprophyla* Lint. *Neosciara cucumeris* Johan. *Neosciara sativæ* Johan. *Leia oblectabilis* Lw. *Joannisia* Sp. *Lestodiplosis* (?) Sp. *Swammerdamella brevicornis* Mq. *Leptocera fontinallis* Fall. *Scotophilella evanescens* Tuck. *Oscinella melancholica* Beck. *Oscinella coxendix* Fitch. *Elachiptera costata* Lw. *Drosophila quinaria* Lw. *Hylemyia cilicrura* Rdi.

HELIANTHUS TUBEROSUS L. *Lepidocyrtus* Sp. *Caecilius impactus* Aaron. *Tyloderma foveolata* Say. *Tyloderma aerea* Say. *Forcipomyia cilipes* Coq. *Neosciara cellaris* (near) Comb. *Lastidoplosis* (?) Sp. *Oscinella coxendix* Fitch.

ANTHEMIS COTULA L. *Aphis maidi-radicis* Forbes.

ARCTIUM LAPPA L. *Aphis maidi-radicis* Forbes. (Associated with *Lasius niger* var. *americana* Emery). Pemphiginæ.

CIRSIUM CANESCENS Nutt. *Baris* Sp. *Aphiochaeta* Sp.

CIRSIUM LANCEOLATUM (L.) Hill. *Baris* Sp. *Eulophid* Sp. *Neosciara cellaris* Comb. *Neosciara cellaris* (Near) Comb. *Nesociara cucumeris* Johan. *Neosciara sativæ* Johan.

TARAXACUM OFFICINALE Weber. *Anuraphis middletoni* Thomas. Pemphiginæ. (In one case associated with Mealy bug, *Trionymus trifolii* Forbes, and *Lasius niger* var. *americana* Emery). *Trionymus trifolii* Forbes. (See above). *Lonchaea polita* Say. *Oscinella coxendrix* Fitch. *Oscinella dorsalis* Lw. *Hylemyia cilicrura* Rdi.

SONCHUS OLERACEUS L. *Drapetis* Sp.

LACTUCA SCARIOLA L. *Hylemyia cilicrura* Rdi.

COMPOSITÆ. Pemphiginæ. (In one case associated with *Crematogaster* Sp.).

A CORRELATION OF STRENGTH AND WEIGHT IN INSECTS.

W. A. HIESTAND,
University of Wisconsin.

I have often marvelled at the apparent strength of the insects, especially in contrast to the strength of man. Anyone who has had the opportunity of observing insects at work must surely appreciate their immense strength. We see small ants carrying forage and building materials which greatly outweigh the insects themselves. Not only can they perform feats of amazing strength but also are able to continue using their muscles without as much fatigue resulting as is the case with man. Perhaps these are the factors which provoked the advice, "go to the ant, thou sluggard."

Let us stop to compare the strength of insects with that of man. The average man is able to pull the equivalent of two to two and one-half times his own weight in an opposing force while a certain small carabid beetle, as my results have shown, is able to pull over forty-five times its own weight in an opposing force. We can not well consider man's strength alone in his ability to move objects as other factors than simply opposing force enter in here. A man may move a two ton automobile by pushing it but of course could not pull with the equivalent of a four thousand pound force. A beetle, on the other hand, can move correspondingly weighty objects by pushing or pulling them as Hinds (3) has shown with *Passalus cornutus*. He found that one beetle could pull a weight of 1250 grams rolling on smooth steel balls over a pane of glass, the weight of the load being 1116 times as great as that of the insect itself. In both of these cases the greatest part of the load was absorbed by gravity and what the man or insect would actually be pulling or pushing against would be the inertia of the object. Hinds, however, found that *Passalus cornutus* could pull favorably against an opposing force of approximately nineteen times its own weight when provided with a proper footing.

Fleas are said to be able to pull seventy or eighty times their own weight. The cockchafer is quoted as being six times as strong as a horse. However accurate these facts are is unknown but they serve to illustrate the immense strength of insects.

Plateau (7) who appears to be the authority of insect strength has compared the strength and weight of various insects has shown that the smaller forms are relatively stronger. The strongest form in his experiments, *Donacia nymphaeæ*, was one of the smallest while the weakest, *sp. Oryctes nasicornis*, was the largest. The thirteen other species he experimented with range in between these two and have strengths in relation to their weights, i. e. being relatively stronger as their weights decrease. Plateau's apparatus was essentially the same as mine and the results of both are strikingly similar. Experimenting with the pushing powers of insects he noted the same correlation as to strength and weight that he found with pulling power. Experimenting also with flying strength of insects he demonstrated that the smaller bees could carry a proportionately greater load than the larger ones.

Herbert Spencer (9) early noted that small size of animals was more favorable to strength. Knowing that mass increases by the cube while surface (and this may be regarded as surface for muscle attachment in exoskeletal types) increases by the square he imagined that an animal continuing to increase in size could reach a point where its muscles would no longer be useful. Thus he accounts for definite size as a characteristic of living organisms. Using the aforementioned law we can see that a creature increasing twice in size and becoming eight times as heavy would be only four times as strong.

Miall and Denny (6) have stated that within the class of insects the relative muscular force is approximately in inverse proportion to their weight. Thus the strength of the insect is most conspicuous in the smaller species. My own results with carabid beetles seem to substantiate this belief, although I did not find an exact correlation, merely an approximate one.

To what is this great strength of insects due? Probably the explanation does not lie alone in the specific nature of the muscles but also in the structure and adaptation of the skeleton. The exoskeleton affords much greater surface for muscle attachment, greater leverage, and greater rigidity, than the

endoskeleton, factors which make it possible for insects, and animals in general with an exoskeleton, to exert greater strength than those fitted with an internal one. Kennedy (4) in comparing the two types of skeletons states that the exoskeleton offers a surface over thirty percent greater than the endoskeleton. Thus is it possible for muscles to be more advantageously placed in the exoskeletal types. In mammals many muscles are grouped to a single tendon while insects are favored with enough surface for individual muscle attachment. It is a known fact that insects possess a greater number of muscles than do vertebrate animals and that the muscles of the former are more highly specialized having better defined striations. Thus it is probable that they are stronger per unit of weight.

The following experiments have been performed upon a few representatives of a single family of beetles, the *Carabidæ*, chosen because this group consists of insects of similar body type and of a considerable range of size. By choosing this family I have largely eliminated other factors than size. For example, most carabids have a typical leg being quite similar in the smaller forms, as *Bembidion*, as well as in the larger ones, as *Calosoma*. The results obtained are by no means conclusive but seem to show a correlation of weight and strength and may serve to stimulate others interested in the same type of work. Only twenty-five beetles were used in the experiment and as I have been unable to continue the work with more, I feel that I have not sufficient data to definitely establish the fact that small insects are relatively more powerful than large ones, but do believe the results are significant enough to state them here and show the relative strength of the beetles.

Apparatus: The apparatus used in measuring the strength of the carabids consisted of a lever mounted horizontally upon a board, i. e. with the axis vertical, with a delicate brass coil spring attached to a point one inch from the fulcrum. The point of attachment of the insect was ten inches from the fulcrum at the other end of the lever. Thus a pull of one-tenth of a gram by the spring could be equalled by a pull of one-hundredth of a gram by the insect. To eliminate the element of friction the lever was balanced by weighting it so that it would come to a horizontal position of rest when the board was placed in a vertical position. By attaching one-tenth gram weights to the point of attachment of the insect with the board

in a vertical position and with the spring attached and marking off on a scale the corresponding positions of the lever the pull of the spring was thus easily calibrated without having to allow for losses due to friction. These points were then subdivided into tenths resulting in a scale calibrated to hundredths of a gram. The scale was graduated from .00 to 5.00 grams but no insect exerted a pull over 4.70 grams. The insects were

DATA SHEET.

Graph Number	Species	Average Strength (grams)	Weight (grams)	Relative Strength S/W
1	Platynus sp.....	.74	.016	46.25
2	Platynus.....	.74	.017	44.12
3	Platynus.....	.70	.022	31.81
4	Anisodactylis.....	1.02	.023	43.44
5	Platynus.....	.92	.033	35.87
6	Harpalus.....	.96	.043	22.32
7	Chlaenius.....	1.02	.043	23.72
8	Harpalus.....	1.41	.062	22.74
9	Anisodactylis.....	1.90	.064	29.68
10	Pterostichus.....	2.45	.120	20.41
11	Evarthrus.....	2.97	.088	33.75
12	Harpalus.....	1.95	.097	20.10
13	Pterostichus.....	2.49	.101	24.65
14	Harpalus.....	2.90	.119	24.37
15	Harpalus.....	2.78	.120	23.17
16	Pterostichus.....	2.45	.120	20.41
17	Pterostichus.....	3.10	.121	25.61
18	Pterostichus.....	3.48	.121	28.76
19	Pterostichus.....	3.28	.124	26.45
20	Geopinus.....	1.85	.155	11.93
21	Evarthrus.....	3.20	.156	20.51
22	Evarthrus.....	2.80	.156	11.94
23	Pterostichus.....	3.10	.182	17.03
24	Evarthrus.....	3.20	.213	15.02
25	Scarites.....	1.95	.342	5.70

fastened by a fine silk thread to the lever by tying a loop around the junction of the thorax and abdomen. A cork track measuring two inches in width and twelve inches in length covered with fine velvet cloth was provided for the insects to secure a footing, and to insure their pulling in a single direction, pasteboard sides were fastened to the cork making a trough-like track. No difficulty was experienced in forcing the insects to pull against the spring. In fact, immediately upon experiencing the pull of the spring they appeared to exert all possible strength in the opposite direction. At times they stopped

pulling and were then touched with a brush and made to pull again. When they appeared to be unable to pull any farther the reading was taken and the insects placed in a container and given two more trials on the following two days. In general, they exerted the greatest pull at the first trial but not always. An average of the three trials was made and recorded later upon the graph. Following the third trial each beetle was killed and weighed to thousandths of grams. There is no assurance that the beetles pulled to their utmost strength but the readings are those of what they actually would pull and beyond which they would not exert themselves.

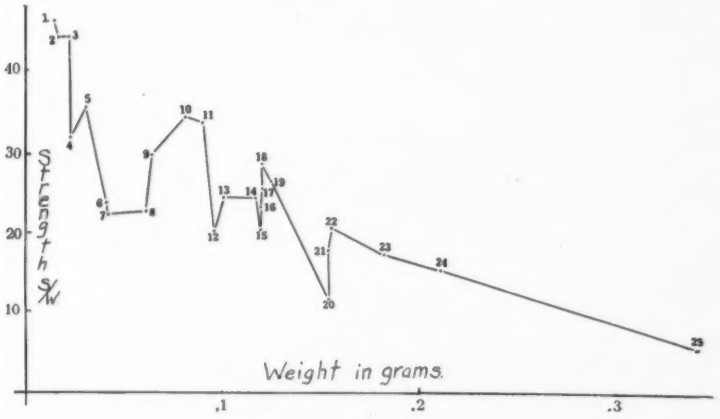

FIGURE 1.

Explanation of graph: The ordinate of the graph represents the strength of the beetles in terms of their weight or S/W, the abcissa represents the weights of the insects. The broken effect of the line shows the variations from the mean, which are to be expected. By using the above two coordinates the points determined show the relative strength of the insects in proportion to their weights. In general, the various points on the graph lie in a zone that corresponds to some extent to the mean. It can be seen from the graph that the small insects in general possess relatively greater strength than the large ones. Rather than commit myself by stating that there is a definite correlation of strength and weight among the insects I prefer to

leave the matter open to question, but I believe the graph has some significance in showing the relatively greater strength of the smaller forms which fact has long been suspected.

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BOOK NOTICES.

ELEMENTARY LESSONS ON INSECTS. By James G. Needham, VIII+206 pages. *Charles C. Thomas, Publisher*, Springfield, Ill. and Baltimore, Md.

As indicated in the title, this is an introductory work intended to aid the beginner in getting acquainted with insects and includes brief description of general structure, general characters of insect orders, mention of important economic species and directions for collecting and preparing insects for study.

DESTRUCTIVE AND USEFUL INSECTS. By C. L. Metcalf and W. P. Flint; 918 pages. *McGraw-Hill Book Co.*, New York. 1928.

This latest addition to the list of Entomological texts is intended for beginning students, and also for a general reference book for farmers and others who desire to know the latest advances in control of insect pests. It is fully illustrated and will be welcomed by entomological workers, and should be a distinct service to the non-entomological public as a source of information concerning our abundant insect life and its relation to human industries and health.

THE HISTORY OF BIOLOGY: A SURVEY. By Erik Nordenskiold, Translated from the Swedish by Leonard Bucknall Eyre. 629 pages. *Alfred A. Knopf, Publisher*, 1928.

The parts of this work which treat of such pioneers in biology as Linnaeus, Fabricuius, Bonnet and Reaumur, and other biologists who used insects extensively in their biological studies will be of special interest to entomologists, in addition to the wealth of information it contains regarding the growth of biological science.

H. O.

CONSTRUCTION AND INSTALLATION OF A TOLUOL-MERCURY THERMOSTAT.*

By Wm. Robinson,
Division of Entomology, University of Minnesota.

The Thermostat.

Its Function: The maintenance of a uniform temperature in a cabinet requires some device which will throw on and off a source of heat; for the ever-varying external temperature renders necessary a counterbalance within the cabinet. This regulation of temperature is effected automatically by the instrument called a thermostat.

Besides compensating for fluctuations in the temperature of the environment, the thermostat is used when a temperature is required continuously above or below that of the surroundings. In the first case the thermostat must throw in heat intermittently to replace that lost through the walls; and in the second it must cause a refrigerant to flow in to neutralize the gain of heat from the outside.

How It Operates: This regulation of temperature is effected by the expansion or contraction of a heat-sensitive material within the thermostat which opens or closes an electric circuit. With certain types of thermostats this is performed by the differential expansion or contraction of two metals which have different coefficients of expansion. With other types the circuit is made or broken by the direct expansion or contraction of a single element. It is the latter type that will be described in the present article. It consists of a somewhat "U"-shaped glass tube of small bore and a thin-walled cylinder, (Fig. 1). The cylinder contains toluol which is a liquid with a high coefficient of expansion. The lower part of the tube holds mercury and near its base a piece of platinum wire has been fused. A metal rod is held in place in the upper part of the tube so that it just touches the top of the mercury column. The upper and lower bands of the thermostat are connected to wires which lead to a battery and relay.

* Published with the approval of the Director as paper No. 777, of the Journal series of the Minnesota Agricultural Experiment Station.

When the temperature rises the toluol expands and forces the mercury up the tube. This then makes contact with the rod and completes an electric circuit which shuts off the heat in the cabinet. When the temperature begins to fall the toluol

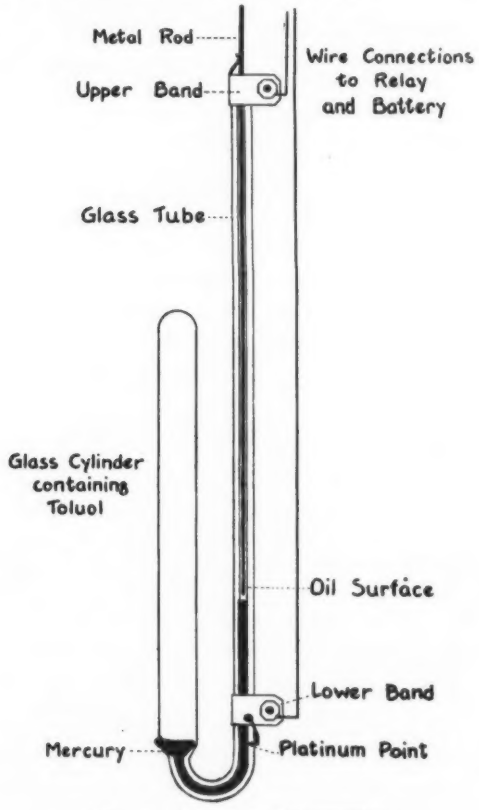

Fig. 1. Side view of thermostat.

contracts and breaks the circuit which allows the heat to come on again.

The efficiency of a thermostat depends partly upon its sensitivity to small temperature changes; upon its durability, and its ease of adjustment. The instrument here described appears to have these qualities, and it is inexpensive to make.

Sensitivity: This requirement is an important consideration, and there are at least five factors involved: the coefficient of expansion of the liquid; the amount of liquid used; the proportion of surface of the liquid to its volume; the diameter of the bore of the tube; and the thickness of the wall of the glass cylinder. The one described gives a sensitivity of about one-quarter of a degree C.

Construction of the Thermostat.

The Glass Container and Parts: These consist, as shown in Fig. 1, of a long glass tube, the lower portion rounded and fused to a thin-walled cylinder. The bore of the tube is 2 mm. and the cylinder is 10 cm. long and 1 cm. wide. The fusing of the cylinder to the tube, while not difficult for anyone who can work with glass, had probably better be done by a local glassblower or by any of the various manufacturers of scientific glassware.

A small piece of platinum wire is also fused into position so that one end extends through into the bore of the tube, Fig. 1. This wire is thus always in contact with the mercury and is part of the electrical circuit. Platinum is used because its coefficient of expansion is very close to that of the glass itself.

Two metal bands are required for each thermostat. These bands encircle the tube; but the ends, instead of overlapping around the tube to make a ring, project outward and are fastened together with a small bolt and two nuts, (Fig. 1). The bands should fit the tube very loosely to permit being set in plaster paris.

Assembling of Parts of Thermostat: Tighten up the first nut on the lower band, slip the band down to its position on the tube and fasten in place with plaster paris. Then solder a piece of copper wire to the platinum wire and to a side of the band.

Have some clean mercury ready to drop into the tube. A burette is convenient for this purpose. It is essential to deliver the mercury directly into the bore, and unless the tip of the burette will go into the bore a piece of glass tubing should be drawn out into a point fine enough to enter. The mercury can then be dropped from the burette through this piece of glass after the toluol is in place.

When the mercury is ready, attach tightly a piece of rubber tubing about eighteen inches long to the top of the thermostat. Place the other end in a bottle of toluol. The toluol should preferably be corked and the tube inserted through a hole because the toluol is slightly inflammable and ordinary laboratory precautions should be observed. The tubing should fit *very loosely* into the cork to allow air movements to and from the bottle.

Heat the cylinder over a Bunsen burner to drive off some air, and when it cools a partial vacuum will form and some of the toluol will be forced in. Boil the toluol carefully and soon a larger volume will be forced in. If the cylinder is not now entirely filled (except for a small

bubble which will disappear when the toluol cools) reheat carefully and cool until this condition is obtained. If any air be left in the cylinder, the thermostat will always be affected by variations in the atmospheric pressure, and the mean temperature for which the thermostat is set will be correspondingly disturbed.

Next detach the rubber tubing from the thermostat and allow the toluol to cool somewhat. However, the mercury should be added while the toluol is still warm, for it is only by the contraction of the toluol that the mercury can be forced up into the cylinder as shown in Fig. 1. The amount of mercury in the cylinder when the toluol has cooled, partly determines the upper range of temperature at which the thermostat can be used. For the toluol cannot again be exposed to a temperature high enough to force all the mercury into the vertical part of the tube, otherwise some toluol will escape.

The lower working limit depends upon the height of the mercury in the tube, for at the time of maximum contraction the column must still be above the platinum point. A thermostat with sufficient mercury in the column to make it adaptable for low temperature cannot be used for certain high temperatures because the mercury will rise above the top of the tube. Thus, the thermostat may be made for any desired temperature, but the range through which it may be used is limited. In making up a number it is well to give them different ranges and mark the range on each.

The upper band may now be fastened in place with plaster paris. This band is similar to the lower one except that it has a spring clip soldered to the back. This clip serves two purposes: It holds the rod in place and it forms a part of the electric circuit. There will probably be some excess toluol in the tube above the mercury which may be absorbed with pieces of wick or string.

The upper surface of the mercury should be covered with an inert liquid which will not evaporate nor conduct electricity. This is to keep air away from the mercury, otherwise oxidation of the mercury will occur during the electric arcing when the circuit makes and breaks. If oxidation is allowed to take place, a non-conducting film will be formed which will greatly decrease the sensitivity of the thermostat. Light lubricating oil appears to serve the purpose satisfactorily.

The metal rod is next inserted into the tube, with the clip on the upper band firmly in contact with it. The thermostat is placed into a holder such as a burette clamp on a ring-stand; and the apparatus is ready for connecting with the relay into the primary circuit.

The Electric Relay.

Its Function: Several types of thermostats are too delicate to take 110-120 volt current used for heating the cabinets. Current of this voltage, therefore, must be regulated by an intermediate mechanism which is called an electric relay. When the relay is connected with a thermostat it serves two purposes: it operates a switch which opens and closes the heating circuit; and it makes and breaks the circuit so quickly and completely that arcing is reduced to a minimum. Some thermo-

stats, chiefly of the bimetallic type, control the heating current direct without any relay. Here the make and break is performed by the differential expansion or contraction of two metals; and this occurs so gradually, under the rise or fall of temperature, that a considerable amount of arcing and fusing of the points frequently takes place as long as the points are close enough together to allow the current to jump across. However, a first-class telegraphic relay snaps into or out of circuit and requires very much less attention on this account. The relay, therefore, permits the use of a current of much higher voltage than the thermostat itself can handle.

How It Operates: The main purpose of the relay in this instance is to operate electrically a switch in the secondary or heating circuit by means of the weaker current from the primary or thermostat circuit. When the mercury rises in the thermostat and makes contact with the metal rod, the primary circuit of between 3 to 6 volts is completed,

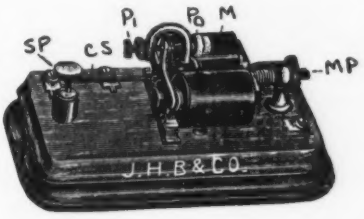

Fig. 2. Telegraphic relay, showing position of parts.
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and a current is sent to the electric relay. This current activates two electromagnets, (Fig. 2, M) which instantly draw toward them a metal key or armature. The key thus comes into contact with the non-conducting post P_0 and breaks the heating circuit, thus shutting off the current to the heating element. When the temperature in the cabinet falls, the toluol in the thermostat contracts and the mercury column recedes. This breaks the primary circuit and the magnets in the relay can no longer hold the key in place because it is under a counterpull from the coil spring CS. The key, therefore, snaps back against the metal post P_1 and closes the secondary circuit, thus causing the cabinet to heat up again. This make-and-break then continues at intervals depending upon the sensitivity of the thermostat. By manipulation of MP, P_0, P_1, or SP, any amount of adjustment may be made.

Source of Current for the Thermostat Circuit: Whenever an electric relay is used with a thermostat, a low-voltage current must be available to activate the electromagnets in the relay. This weak current may be obtained from any one of several sources. The cheapest is the ordinary dry cell. This gives a current of about 1½ volts, and two or more may be connected in series according to the work to be done.

The ordinary storage battery of one or more cells may be used; however, both the dry cell and the storage battery require frequent testing and renewal to keep up the voltage, as of course they run down with use. Nevertheless, where only one or two cabinets are to be operated, probably one or the other type should be recommended.

When a larger number of cabinets are to be used, very satisfactory results may be obtained with a trickle charger connected up to the house lighting current. It costs no more than the storage battery; it supplies a continuous direct current of low voltage sufficient to take care of several relays should they all be in circuit at the same time; and it requires no attention.

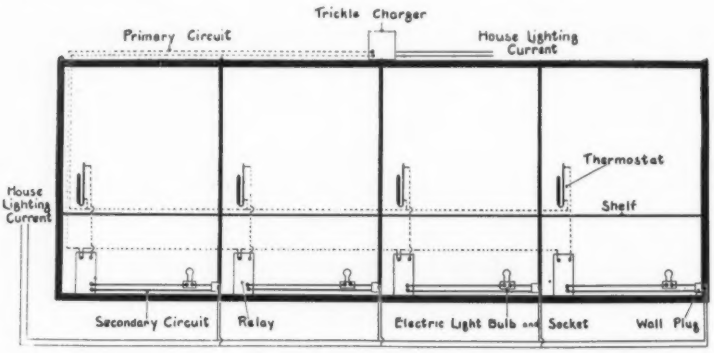

Fig. 3. Diagram showing electric connections for one or several cabinets.

Installation of Parts.

Adjustment of Relay: The electric connections of the heating and the thermostat circuits within the cabinet are next in order. These are not at all difficult to make, only the usual care in making firm connections and in insulating against short circuits being necessary.

If the relay is the usual one-way type the key, as it snaps back and forward from posts P_0 and P_1, will open and close just the one circuit. In this case, see that the non-conducting post P_0 is above and that the conducting post P_1 is below the switch. Adjust either the posts MP or$_0$ P so that the key cannot get into contact with the core of the magnet. Then adjust P_1 so that the key will have some play backward and forward. Adjust post SP until the coil spring will bring enough pull upon the key to move it away from the magnet when the current is off. Obviously the downward pull of the coil spring should always be considerably less than the upward pull of the magnet.

Installation of Relay: The relays are now ready to be installed, and the heating circuit should be connected to each one as shown in the diagram; that is, with the heating element itself in series. This circuit

is complete and separate for each cabinet. The thermostat circuit is connected up in parallel; that is, each cabinet is operated independently of the others but the one general wiring serves for all. This greatly simplifies the thermostat wiring. One wire is brought down from the trickle charger and connected with one of the posts of a relay, as shown in Fig. 3. Then the same wire is continued to the second relay and so on, ending only at the post of the last one. Of course, the insulation must be removed from the wire where it comes in contact with each post.

Installation of Thermostat: The thermostats are next to be placed in position, the second wire from the trickle charger brought down and connected successively with each thermostat, as shown in Fig. 3. A short length of wire in each case connecting the unoccupied posts of the thermostat and relay completes the circuit. We now have the thermostat and relay connected in parallel, and any one system may work independently of the others, or all may function at the same time, as the temperature requirements may be. When each cabinet has been brought to its required temperature and the thermostat has come into equilibrium with it, then the rod is raised or lowered until it just comes in contact with the mercury column. A few subsequent readjustments of the rod may be necessary before the required temperature control has been effected.

A small electric fan is recommended for each cabinet to circulate the air. If the fans of two or more cabinets are connected in series, the speed of each will be much reduced and more satisfactory operation obtained.

Care of Apparatus.

Fusion of Relay Points: Fusing of the contact points of the relay should not occur if the relay is not overloaded. An electric light bulb of 50 to 75 watts would give a load of not more than ¾ amps. If for any reason the points become fused, their surface should be renewed with a fine file or piece of emery cloth. Care must be taken, however, to keep their surface flat so that they will come fully into contact with each other.

Mercury and Oil Contacts: After considerable use the upper surface of the mercury may form a slightly oxidized layer despite utmost precautions; and probably the best thing to do is to remove some of the mercury with a small pipette and to replace with fresh mercury. The oil tends to break down slightly under the sparking of the primary circuit. This may necessitate occasional renewal of the oil, which can be readily done.

THE HEAT SENSITIVE AREAS OF CERTAIN GRASSHOPPERS.*

By Robert M. Geist,
Capital University, Columbus, Ohio.

It is very well known to entomologists that insects react generally to heat, as this medium has been used extensively as a method of insect control. However, very little work has been done on the response of insects to localized heat stimulation.

These experiments were planned to ascertain whether the whole body is equally sensitive to heat or whether certain portions of the body are more sensitive than others.† The latter seems to be the case in responses to touch and taste stimuli as noted by Folsom (1).

The grasshopper was chosen for these experiments because of its size, abundance and the relatively easy method of handling. The experiments were carried out on both adult and nymphal specimens of *Melanoplus femur-rubrum* De G. *Melanoplus differentialis* Uhler and *Disossteira carolina* Linn. These insects were all taken in the fields east of Columbus during August 1927.

Three types of experiments were performed: 1. Radiant heat was applied equally on the surface on which the animal rested. 2. Radiant heat was applied to various special parts of the body by a heated wire loop. 3. Radiant heat was applied by means of the wire to one side of the animal while heat absorption by exposure to ice, was applied to the opposite side of the animal. The apparatus used in applying the heat was of two kinds.

The apparatus used in Type I consisted of a small electric heater upon which rested a flat nickeled piece of steel. The animals were placed on the steel and covered with an inverted glass funnel in the top of which a thermometer was placed. The current was then turned on for a few seconds while the actions of the animal were noted at the successive temperatures.

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* Contribution from the Department of Zoology and Entomology, Capital University, Columbus, Ohio.

† These experiments were suggested by Dr. W. M. Barrows, of the Department of Zoology and Entomology of the Ohio State University, to whom thanks are expressed for his direction and criticism throughout the work.

The results are as follows:

TYPE IA. The animals used were *M. femur-rubrum* and *D. carolina*. The eyes of the animals were not blackened. The hopper was placed on the steel under the funnel and the heat turned on. The air temperature in this case ran up to the maximum of 49.4°C. At first the animal stroked its antennæ with the fore legs. As the steel became hotter the front tarsi were held up off of this. This was particularly true of the hind and fore tarsi, the middle ones seeming to be less sensitive. As the temperature approached 37.5° the animal hopped continually. Finally at 48.8° the jumping legs seemed to cramp and were drawn up tight against the body and the animal soon died. Some of the hoppers alternately raised and lowered the legs for support. The abdomen was kept off the steel, and frequently the tibial spurs were used to support the animal so that the tarsi did not touch the steel. As the higher temperatures were reached the animal pulled itself around with the first two pairs of legs while holding the hind legs up tight against the abdomen. One hundred animals were used in this type experiment.

TYPE IB. All three species were used. The animals were decapitated and placed on the steel. The responses were similar to those of Type Ia. The tarsi were held up off the steel and the animal began to jump violently with cramps and paralysis following. Usually these animals became inactive and cooked at 41.0°C. The responses were slower but very similar to Ia. Thirty-five animals were used.

TYPE IC. All three species were used. The eyes and ocelli of the hoppers were blackened with asphaltum varnish and lamp black. This was done to prevent stimulation by light. The animal was tested by placing it on a flat surface and turning the surface around in front of a window. If the animal remained motionless the blackening was sufficient, but if it moved with the light the eyes were given another coat of the varnish. The hoppers were then placed on the heater. The tarsi were held up as before and the antennæ stroked slightly. At 37.7°C the animals began to jump violently. As the temperature neared 49.4°C death followed this violent jumping. These results were also similar to Type Ia. Fifty animals used.

TYPE ID. All three species of animals used. The antennæ were cut off close to the head. The animals were then placed on the heater. They did not seem to be affected by the heat at first but soon hopped as violently as the others and held up the tarsi or supported themselves on tibial spurs. At 41.5°C the animals died after violent jumpings. Twenty animals used.

TYPE IE. All three species used. Here the tarsi of the hind and fore legs were cut off and the animals placed on the heater. The hind and fore legs were held up as before, the animal being supported on the middle ones and alternately raising and lowering the others. Soon violent jumping occurred. At 43.3°C cramps set in in the hind legs and at 49.4° the animals died. Thirty animals used in this case.

The apparatus used in Type II experiment consisted of a toy transformer to which was attached a wired wood handle terminating in a loop of special resistance wire similar to that used in electrical heating appliances. The transformer was plugged into the laboratory current and the voltage reduced from 110 to 4½. A rheostat was used in connection with the transformer so that the voltage could be changed at will. With the couplet used the voltage could be increased to 10, however it was found that 4½ volts suited the purpose better. A heat of 65°C was obtained in this manner at a distance of one-eighth of an inch from the thermometer. This was the distance used in the experiments.

TYPE IIA. All three species of hoppers used. The eyes and ocelli were blackened and the loop apparatus used. If the loop were held above the antennæ they moved slightly and if it were moved from the apex to the base of the antennæ these latter dropped as the loop approached the base seeming to show that the antennæ are more sensitive at or near the base. If the loop were held to the mouth parts they were immediately stroked with the fore legs. If the loop were held close to the legs they were lifted from the table and held in the air away from the loop. When held close to the posterior end of the abdomen, the wings, in those animals where they were developed, were moved. The insects did not respond to the loop when held to the head or the thoracic shield. If the loop were held to the ventral side of the abdomen the animal shifted its position sideways, this being true also when the loop was held over the dorsal side. When the loop was held in a position so that a

sensitive spot on the animal was close to it for several minutes the animal jumped. One hundred animals used.

TYPE IIB. All three species used here. The animals were decapitated and the loop used as in Type IIa. The response was similar to that recorded in Type IIa but slower. Thirty-five animals were used.

TYPE IIC. All species of insects used. Animals exposed to the heat on the heater were taken off and after cooling were exposed to the heat of the loop. One would expect that the previous heating on the steel would make the responses to the loop much slower. This is just what occurred except that in a few cases those parts previously tested lost their sensitiveness entirely. Fifty hoppers were used in this experiment.

TYPE IID. All species used. In this case the antennæ were cut off as before and the loop was used on the animals. The head did not seem to be sensitive but all portions of the body previously mentioned reacted as before. Thirty animals were used.

In the third type of experiment the animal was placed upon a slight elevation and was exposed to ice in the form of small cubes on one side and to the wire loop on the other. The purpose of the elevation was to allow the cool moist air from the ice to settle underneath the platform on which the animal rested thus assisting in keeping the humidity the same on both sides of the animal.

All three species of the insects were used. The eyes and ocelli were blackened. At first the animal drew away from the heat toward the ice but in a few moments came back closer to the heat. In every case the animal drew away from the heat. If then the heated loop were pressed closer to the hopper it took a position closer to the ice. Several animals climbed onto the ice at this time and when experimented upon with heat afterwards died almost instantly. Twenty-five animals were used.

The total number of grasshoppers used was four hundred seventy-five.

In conclusion we can summarize the results by saying that the grasshopper appears to be slightly sensitive to heat over almost the entire body surface but that the following parts in the order given are the more sensitive: antennæ, middle down

to base; pulvilli and tarsi of hind and fore legs; dorsal and ventral side of abdomen; palps; middle tarsi. No evidence was secured that these grasshoppers respond to heat stimulation by means of eyes or ocelli.

While the methods which we employed are different from those used by Herter, who studied the field cricket, yet the results parallel each other closely. Herter's conclusions from his study of *Lyogrillus campestris* rather freely translated are as follows:

1. The field cricket shows temperature responses a little weaker than the house cricket.
2. The male and female of *L. campestris* show in diffused daylight and in the dark a temperature optimum of the same height.
3. The temperature optimum for normal field crickets is about 26°C.
4. The field cricket without antennæ has a simliar optimum.
5. The field cricket without cerci, without first tarsi, without maxillary palps, without labial palps or completely without palps shows a temperature optimum 2 to 4 degrees higher than the normal.
6. The upper temperature limit, about 40.5°C, calls out in normal field crickets a negative reaction.
7. The field cricket without cerci has a "terror reaction" zone about as high as normal.
8. The field cricket without antennæ, without pre-tarsi, without maxillary palps, without labial palps, without all palps has a "terror reaction" zone higher than normal.
9. The thermal irritability of single body parts of the field cricket is different and is given in the following order of importance: palps; fore legs; cerci; ovipositor; antennæ; middle leg; hind leg; wing and abdomen; prothorax and head.
10. The field cricket shows in optimum and above optimum temperature extreme head cleaning reflexes.
11. The field cricket perceives by aid of antennæ temperature variations yet these play no important role in thermotaxis.
12. The thermotactic significance of the separately investigated body parts follows in the order of importance: fore tarsi; palps; cerci; antennæ.

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NEW NEBRASKA SPIDERS.*

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Recent collections of spiders in the state of Nebraska have revealed the following new species.

Brachybothrium lincolnianum n. sp.

Male. In life, black or fuscous in color, the venter lighter than the dorsum and the carapace somewhat lighter than the abdomen. In alcohol, this color changes to a yellow or brown, the cephalothorax then being yellowish and the abdomen darker, a soft brown or tan. Eye area twice as wide as long; anterior median eyes separated from each other by an interval equal to more than twice the diameter of one of them and from the anterior lateral eyes by a space only slightly greater; the latter have a diameter two and one-half times that of the former. The posterior median eyes are as far apart as are the anterior lateral eyes, while the posterior lateral eye, the posterior median eye, and the anterior median eye of each side are in a row and form almost a straight line. The posterior lateral eyes have a diameter two-thirds as great as that of the posterior median eyes, while the posterior median eyes have a diameter about three-fourths that of the anterior lateral eyes, which are by far the largest eyes; posterior row slightly longer than the anterior. Legs as follows:

	Fem.	Pat.	Tib.	Met.	Tar.
First leg.....	4.6 mm.	2.0	3.7	3.4	2.0
Second leg.....	4.0	1.6	2.8	3.0	1.7
Third leg.....	3.4	1.8	2.4	3.2	2.4
Fourth leg.....	4.0	1.6	3.0	4.4	2.2

Total length 9.6–10.0 mm., cephalothorax 4.8–4.9 mm.

Type locality: Lincoln, Nebraska. Four males; March and April; on clay banks near deciduous forest. University of Nebraska collection; D 135.

This species is easily distinguished from *B. pacificum*, whose hypothetical range includes Nebraska, by the eye arrangement. *B. pacificum* has the anterior median eyes separated by a distance not exceeding the diameter of one of them, in the male; in the female, these eyes are separated by a distance not exceeding one and one-half times the diameter of one of them. The

* Studies from The Zoological Laboratory, The University of Nebraska, No. 158.

palpus of *B. lincolnianum* is also different (Fig. 1). The palpus of a specimen of *B. pacificum* from this laboratory is drawn for comparison (Fig. 2).

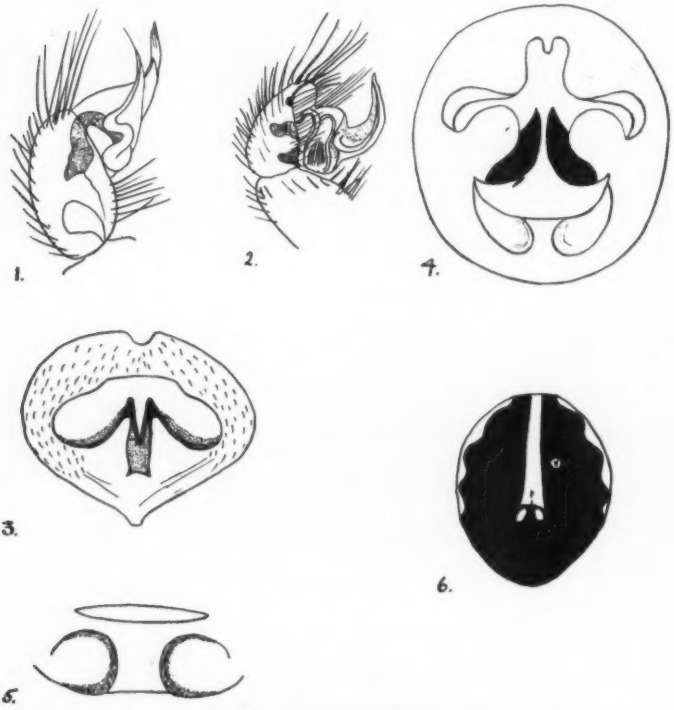

Fig. 1. Male palpus of *Brachybothrium lincolnianum* n. sp., side view.
Fig. 2. Male palpus of *Brachybothrium pacificum* Simon, side view.
Fig. 3. Female epigynum of *Nodocion rufithoracica* n. sp.
Fig. 4. Female epigynum of *Nodocion zelotoides* n. sp.
Fig. 5. Female epigynum of *Lithyphantes cyaneus* n. sp.
Fig. 6. Dorsal view of female abdomen of *Lithyphantes cyaneus* n. sp.

Nodocion rufithoracica n. sp.

Female. Carapace and sternum, posterior two pairs of legs and femora, patellæ and basal segments of anterior two pairs of legs, yellowish-brown; distal joints of anterior two pairs of legs, palpi and mandibles reddish-brown; area between the anterior median eyes almost black; abdomen a uniform light gray dorsally and ventrally,

except epigynum which is deep reddish-brown. Anterior row of eyes very slightly recurved and eyes almost equal in size, the laterals slightly larger; the space between the anterior median eyes nine-fourteenths the width of a single median eye; anterior median eyes twice as far from each other as from the lateral eyes; posterior eye-row procurved slightly and the eyes almost equidistant, but the posterior median eyes are slightly farther from each other than from the posterior lateral eyes; median eyes oblique, three-tenths the width of their greatest diameter apart, and larger than the lateral eyes; eye-rows of equal length. Cheliceræ entirely unarmed below; upper margin of cheliceral furrow with three small nodules or teeth, two at the anterior inner apex and a third somewhat nearer the base on the inner margin. Femora with numerous bristles dorsally; tibia III and IV with no median dorsal spines. Epigynum (Fig. 3) consists of two semicircular wing-like plates united by a transverse ridge, from the center of which extends posteriorly a narrow septum which disappears and is replaced by a narrow trench behind.

Length 7.0 mm., cephalothorax 2.7 mm. Length of tibia and patella I, 2.6 mm.; tibia and patella IV, 2.7 mm.

Type locality: Mitchell, Nebraska; June 21, 1923. Under stones on short-grass plains. University of Nebraska collection; D 502.

Nodocion zelotoides n. sp.

Female. Entire body black or very dark brown, resembling *Zelotes subterraneus* (C. Koch). Venter lighter than dorsum; mandibles dark brown. Anterior row of eyes slightly recurved with the anterior median eyes smaller than the anterior lateral eyes; space between the anterior median eyes almost as great as the width of an anterior median eye; posterior eye-row procurved slightly and eyes equidistant; posterior median eyes oblique, two-sevenths the width of their greatest diameter apart, and larger than posterior lateral eyes; posterior eye-row slightly longer than anterior. Lower margin of the cheliceral furrow entirely unarmed and smooth; upper margin armed with three distinct teeth. Femora with numerous bristles dorsally. Tibia III and IV each with a single median dorsal spine. Epigynum (Fig. 4) somewhat resembles that of *Drassylus rufulus* (Banks), but the median anterior excavation extends much farther forward than the lateral excavations.

Length of body, 6.1 mm.; cephalothorax, 2.3 mm.; tibia and patella I, 2.0 mm.; tibia and patella IV, 2.1 mm.

Type locality: Mitchell, Nebraska; August 5 and 11, 1923. Under dung and in alfalfa. University of Nebraska collection; D 561.

Lithyphantes cyaneus n. sp.

Female. Cephalothorax ground color pale yellow to reddish-yellow or orange; eye region black; cephalic part of cephalothorax separated

from thoracic part by a dark gray stripe; femora reddish-yellow, other joints yellow; sternum, mandibles and maxillæ black or dark brown; coxæ reddish brown; abdomen almost iridescent blue-black with a bright white stripe with scalloped edges on each side and a third extending down the middle from the base to within one-fourth the distance from the tip; venter blue-black with two fine white stripes extending on each side from near the base to within a very short distance of the spinnerets. Clypeus narrow. Anterior eye-row straight; posterior eye-row procurved and slightly longer than anterior row; anterior median eyes the smallest and twice their diameter apart; anterior eyes almost equidistant; posterior median eyes scarcely more than their diameter apart, but they form with the anterior median eyes a rectangle; posterior lateral eyes twice the width of the diameter of a single posterior median eye apart; posterior lateral eyes somewhat smaller than posterior median eyes. The epigynum (Fig. 5) has a central septum which separates two pits. Fig. 6 gives the appearance of the abdomen.

Length of body, 4.6 mm.; cephalothorax, 1.9 mm.

Type locality: Haigler, Nebraska; June 4, 1927. Swept from *Asclepias*, *Typha* and *Scirpus*. University of Nebraska collection; D 669.

The North American species of *Lithyphantes* known to the author may be separated as follows:

Anterior median eyes larger than the others.....*pulcher* Keys.
Anterior median eyes equal in size to the others or smaller than them.
  Anterior median eyes noticeably smaller than the posterior median eyes.
    Abdomen light colored with four pairs of dark spots.....*mimoides* Chamb.
    Abdomen black or blue-black with three light stripes.....*cyaneus* n. sp.
  Anterior median eyes scarcely smaller than posterior median eyes.
    Cephalothorax shorter than femur I; cephalothorax and legs yellow, *corollatus* L.
    Cephalothorax longer than femur I, or at least as long; cephalothorax and legs reddish.....*fulvus* Keys.

NEW SPECIES OF CRANE-FLIES FROM SOUTH AMERICA. PART II.*

(Family Tipulidæ, Order Diptera).

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The majority of the crane-flies discussed at this time are from *Chile* and *Patagonia*, where they were collected by Messrs. Faz, Jaffuel and Pirion. A few additional specimens were secured by Mr. Merkle and kindly sent to me by Dr. Carlos Bruch. Additional species described in this report are from *Argentina*, collected by Mr. and Mrs. Raymond C. Shannon; *Paraguay*, taken by Mr. F. Schade; and *Ecuador*, where they were secured by Mr. G. H. H. Tate. I am very greatly indebted to all of the above named persons for the opportunity of studying this important series of Neotropical Tipulidæ. Except where stated to the contrary, the types of the novelties are preserved in my collection.

Microtipula Alexander.

Microtipula (Microtipula) **legitima** sp. n.

General coloration buffy yellow, the praescutum with three brown stripes, the median stripe still darker; antennal flagellum black; legs black, the femora with a yellow subterminal ring; wings extensively whitish, sparsely variegated with brown; cell *C* uniformly darkened; abdominal tergites obscure yellow, with three dark brown longitudinal stripes.

Male. Length about 8-8.5 mm.; wing, 8.8–9.2 mm.

Female. Length about 10 mm.; wing, 10 mm.

Frontal prolongation of head brownish black, the nasus short and stout; palpi black. Antennæ with the scape light yellow, flagellum black; antennæ (♂) relatively elongate, if bent backward extending about to one-fourth the length of the abdomen; terminal segment very small. Antennæ (♀) shorter, if bent backward extending about to wing-root. Head greyish brown, the anterior vertex and frons more yellowish.

Pronotum buffy yellow with a dark brown median line. Mesonotal praescutum buffy yellow, with three brown stripes, the median stripe further divided by a very conspicuous black median vitta; posterior

* Contribution from the Department of Entomology, Massachusetts Agricultural College.

sclerites of mesonotum brown, pruinose. Pleura yellow, with two greyish longitudinal stripes; dorso-pleural region pale yellow. Halteres pale, the stem a little darkened outwardly, the knobs conspicuously pale yellow. Legs with the coxæ pale buffy brown; trochanters obscure yellow; femora black, the bases very narrowly and indistinctly brightened; a narrow yellowish subterminal ring some distance before apex; remainder of legs black. Wings with the disk extensively whitish, sparsely variegated with grey clouds that are chiefly marginal; cell *C* uniformly darkened; cell *Sc* yellow with four brown areas; two or more less continuous fasciæ cross cells *R* and *M* into the cubital and anal cells; wing-apex chiefly darkened, not variegated by marginal pale areas; stigma dark brown, confluent with the dark costal cell and a conspicuous dark seam on the anterior cord; prearcular field with cells *C* and *Sc* dark, the remaining cells whitish; veins dark brown. Macrotrichiæ of veins relatively long and conspicuous. Venation: R_{1+2} entirely atrophied; cell *1st* M_2 pentagonal, narrowed outwardly; petiole of cell M_1 more than twice *m;* cell *2nd A* relatively wide. In the female, the white ground-color of the wing is even more extensive, including portions of all the posterior cells, most extensive in cells R_5 and M_4.

Abdominal tergites obscure yellow with three dark brown longitudinal stripes that widen out on the outer segments, restricting the ground-color; subterminal segments almost uniformly blackened; hypopygium obscure yellow; sternites obscure yellow with a median brownish black stripe. Ovipositor with the tergal valves slender, straight, or even slightly decurved.

Habitat: Paraguay. *Holotype*, ♂, Villarica, October 25, 1925 (F. Schade). *Allotype*, ♀, Santa Barbara, October 17, 1925 (F. Schade). *Paratopotypes*, 3 ♂, ♀, September 9—October 14, 1925; *paratypes*, 1 ♂, Caraveni, September 20, 1925; 1 ♂, with the allotype, October 10, 1925 (F. Schade).

Microtipula (Microtipula) **atrovelutina** sp. n.

General coloration yellow; praescutum with three brownish black stripes; a conspicuous velvety-black spot on lateral margin of praescutum opposite the pseudosutural foveæ; antennal flagellum black; femora obscure yellow, the tips blackened, preceded by a clearer yellow subterminal ring; wings with the disk greyish, the margin darker; cell *Sc* bright yellow with four brown areas.

Male. Length about 8.5 mm.; wing, 10.5 mm.

Frontal prolongation of head light yellow, brown above; nasus distinct; palpi dark brown. Antennæ (♂) relatively long, if bent backward extending about to the root of the halteres; scape yellow, the flagellum black; flagellar segments cylindrical, the basal enlargement more evident on the outer segments. Head yellow.

Pronotum light yellow. Mesonotal praescutum obscure yellow with three brownish black stripes, the median stripe narrowed and subobsolete behind; scutum obscure yellow, each lobe largely blackened;

posterior sclerites of notum greenish yellow. A conspicuous velvety-black spot on the lateral margin of the praescutum and dorso-pleural region, immediately laterad of the pseudosutural foveæ. Pleura obscure yellow, the ventral pleurites more infuscated. Halteres dark brown, the base of the stem obscure yellow. Legs with the coxæ obscure yellow, the fore coxæ darkened at base; trochanters obscure yellow; femora obscure yellow, the tips broadly blackened, preceded by a subequal brighter yellow ring; tibiæ brownish testaceous, a little darkened outwardly; tarsi passing into brown. Wings with the disk extensively greyish; cell *Sc* bright yellow, with four brown areas, the first extending into cell *C;* stigma dark brown, confluent with a paler brown seam along the cord; wing-apex narrowly infumed; bases of cells *R* and *M* darkened; a dusky area near midlength of vein *Cu* in cell *M;* veins brown. No macrotrichiæ in cells of wing. Venation: R_{1+2} entirely atrophied; *Rs* relatively long and straight; cell M_1 with the petiole longer than *m*.

Abdominal tergites bright yellow, the lateral margins of the segments blackened, the subterminal segments and hypopygium blackened; sternites obscure yellow, the terminal segments blackened.

Habitat: Paraguay. *Holotype*, ♂, Santa Barbara, October 17, 1925 (F. Schade).

Microtipula (Eumicrotipula) **iguazuensis** sp. n.

Antennæ (♂) elongate, bicolorous; mesonotal praescutum obscure yellow, with three brownish black stripes, the median stripe paler in front except for a capillary median vitta; pleura obscure yellow, with longitudinal brown stripes; legs black, the femora with a narrow subterminal yellow ring; wings with a brownish suffusion, handsomely variegated with yellow spots, including a submarginal series in cells R_3 to M_4 inclusive; cell M_1 sessile to short-petiolate; cells of distal half of wing with abundant macrotrichiæ.

Male. Length about 7.5 mm.; wing, 9.5 mm.

Female. Length about 9 mm.; wing, 10 mm.

Frontal prolongation of head obscure yellow; nasus small; palpi dark brown, the terminal segment paling into orange. Antennæ (♂) relatively elongate, if bent backward extending to about one-third the length of the abdomen; scape light yellow, the flagellar segments bicolorous, the base of each segment black, the apex yellow, the latter color becoming more obscure on the outer segments; distal flagellar segments more uniformly darkened. Antennæ (♀) short. Head infuscated, paler in front.

Mesonotal praescutum obscure yellow with three brownish black stripes, the median stripe paler in front except for a continuous median dark vitta; scutum brownish grey, each lobe with two blackish areas; scutellum yellowish testaceous, the parascutella dark; postnotum dark, more or less pruinose. Pleura obscure yellow, longitudinally striped with blackish, including a conspicuous dorsal area on the anepisternum and pteropleurite and a more ventral stripe on the sternopleurite and

meron. Halteres light yellow, the knobs infuscated, with their tips pale. Legs with the coxæ pale; trochanters obscure yellow; femora black, the bases restrictedly yellow; a narrow yellow ring before the slightly wider black tips; remainder of legs black. Wings with a strong brownish suffusion, handsomely variegated with creamy yellow spots; cell *C* chiefly darkened, variegated by a yellow subbasal and a more extensive subterminal area; post-stigmal yellow area extending to the wing-apex in cell R_5; a series of yellow submarginal spots in cells R_2 to M_4 inclusive; cell *1st A* with two similar areas; cell *M* variegated with two large yellowish areas that cross vein Cu_1; a conspicuous pale area at the arculus; veins dark brown, paler in the yellowish areas. Abundant macrotrichiæ in all cells of distal half of wing. Venation: Cell M_1 sessile or short-petiolate.

Abdomen chiefly dark brown, the basal sternites variegated with obscure yellow; caudo-lateral margins of the tergites restrictedly pale; sternites chiefly yellow; hypoygium obscure yellow.

Habitat: Argentina. *Holotype*, ♂, Iguazu Falls, October 3-5, 1927 (R. and E. Shannon). *Allotopotype*, ♀. *Paratopotypes*, 3 ♂ ♂. Holotype in the U. S. National Museum.

Tipula Linnaeus.

Tipula fraudulenta sp. n.

Allied to *T. bellardiana* Alexander (Mexico); antennæ bicolorous; femora yellow with a narrow black subterminal ring; wings with a creamy ground-color, handsomely variegated with narrow brown zigzag crossbands; vein R_{1+2} entirely atrophied; ovipositor with the tergal valves gently decurved.

Female. Length about 11 mm.; wing, 13 mm.

Frontal prolongation of head brown; palpi dark brown. Antennæ more or less bicolorous, the basal segments obscure yellow; bases of the succeeding segments darkened; outer segments more uniformly darkened.

Mesonotum discolored, the praescutum obscure yellow, with indications of a median stripe in front; scutal lobes conspicuously marked with brown; scutellum greenish yellow. Pleura obscure yellow, variegated with darker. Halteres yellow, the base of the knob a little darkened. Legs with the coxæ brown; trochanters yellow; femora yellow with a narrow black ring before the tips; tibiæ obscure yellow, the tips darkened; tarsi passing into dark brown. Wings with a cream-colored ground, handsomely variegated by narrow brown crossbands; cell *C* uniformly infuscated; cell *Sc* variegated with about three brown areas; a nearly complete brown fascia extending from the stigma obliquely across the wing before the cord to vein Cu_1, thence along this vein to the wing-margin; a broader incomplete brown fascia in cells R_2 and R_3; a narrow brown marginal seam around the wing-apex, the veins similarly seamed with brown, leaving submarginal creamy areas of

various sizes in the centers of the cells; a narrow zigzag brown fascia crosses the wing from the origin of *Rs* to the caudal margin in cell *1st A;* base of cell *Cu* darkened; veins yellow, darker in the infuscated areas. Venation: R_{1+2} entirely atrophied; R_3 elongate, nearly straight; cell *1st* M_2 small, pentagonal; petiole of cell M_1 a little longer than *m*.

Abdomen discolored, the tergites apparently yellowish testaceous, the outer segments darker. Ovipositor with the tergal valves slender, gently decurved toward tips; sternal valves short.

Habitat: Ecuador. *Holotype*, ♀, Pallatanga, altitude 4400 feet, March 28, 1922 (G. H. H. Tate).

Tipula nigrovariegata sp. n.

Female. Length about 17 mm.; wing, 14.5 mm.

Allied to *T. macrosterna* (Alexander) and *T. trinidadensis* (Alexander), differing expecially in the arrangement of the thoracic pattern and the coloration of the legs.

Frontal prolongation of head yellow, dark brown above; palpi obscure yellow. Antennæ yellow, the outer segments darkened. Head obscure brownish yellow.

Mesonotal praescutum shiny yellow, with black stripes, the median stripe so colored only on the cephalic third, the posterior portion being more ferruginous; lateral stripes entire, curved outwardly to the margin, narrowly connected along the pretergal region with the median stripe; scutum yellow and ferruginous, each lobe with a single circular black area on cephalic lateral portion. Pleura yellow, the propleura extensively darkened; anepisternum extensively darkened. Halteres yellow, the knobs darkened. Legs with the femora brownish black, only the narrow bases obscure yellow; tibiæ obscure yellow, the tips narrowly darkened; tarsi passing into dark brown. Wings with a strong grayish yellow suffusion, the base and costal region more suffused; stigma a little darker than the ground-color; veins yellowish brown.

Abdomen with the basal tergites yellowish, the subterminal segments black; lateral margins of the intermediate segments broadly blackened. Ovipositor with the fleshy tergal valves fulvous.

Habitat: Ecuador. *Holotype*, ♀, Ventura, altitude 1400 feet, April 10, 1922 (G. H. H. Tate).

Tipula inarmata sp. n.

Allied to *T. armatipennis* Alexander; antennal flagellum black; wings (♂) without a costal spur; male hypopygium with the lobes of the ninth tergite slender, divergent and slightly decurved; appendage of eighth sternite with an apical emargination.

Male. Length about 14 mm.; wing, 14 mm.

Frontal prolongation of head relatively short, shiny ferruginous; nasus distinct; palpi obscure yellow. Antennæ (♂) relatively long, if bent backward extending to some distance beyond the base of the abdomen; scape yellow; first flagellar segment obscure yellow, darkened

outwardly; remainder of flagellum black; flagellar segments conspicuously incised, the basal and apical enlargements subequal; verticils shorter than the segments. Head buffy yellow.

Mesonotum buffy yellow, with scarcely evident stripes; posterior sclerites clearer yellow. Pleura yellow. Halteres obscure yellow, the knobs a little infuscated Legs with the coxæ and trochanters yellow; remainder of legs yellow, the tarsi passing into dark brown. Wings yellowish grey, the prearcular and costal regions yellow; stigma brownish yellow. No spur on costa near stigma, as in ***armatipennis***, this region a trifle dilated. Venation: *Rs* short and strongly arcuated; R_{1+2} very short and oblique, the cell being unusually wide; cell *1st* M_2 small, long-pentagonal; petiole of cell M_1 more than twice *m*.

Abdominal tergites yellow, the lateral margins broadly infuscated, most conspicuous on the intermediate segments; median dark stripe less indicated; subterminal segments black; hypopygium castaneous. Male hypopygium with the tergite broader than long, the median area further produced into two slender divergent, slightly decurved spines that are separated from one another by a V-shaped notch. Eighth sternite produced caudad to beyond the level of the remainder of the hypopygium into a shovel-like scoop, the apex of which has a U-shaped emargination.

Habitat: Argentina. *Holotype*, ♂, Puerto Bemberg, Misiones, October 8, 1927 (R. and E. Shannon). Holotype in the U. S. National Museum.

Tipula lanigera sp. n.

Belongs to the ***glaphyroptera*** group; general coloration gray, the praescutum with four brown stripes, in addition to the broad brown lateral margins; antennal flagellum dark; femora obscure yellow, the tips blackened, preceded by a narrow clearer yellow subterminal ring; wings brown, variegated with darker brown and pale areas; abdomen yellow, the tergites with sublateral dark stripes, the outer segments uniformly darkened; abdomen of male with long conspicuous white setæ on the ventral surface of sternites four to seven.

Male. Length about 13 mm.; wing, 16.5 mm.

Frontal prolongation of head brown; nasus long and slender; palpi brownish black. Antennæ with the scapal segments obscure yellow, the first darker above; flagellum brownish black, the basal enlargement of the segments a trifle darker in color; longest verticils about as long as the segments; antennæ of moderate length, if bent backward extending about to the halteres. Head grey, the center of the vertex infuscated.

Mesonotum gray, the praescutum with four entire brown stripes, in addition to the broad brown lateral margins; scutum gray, each lobe with two nearly contiguous brown areas; posterior sclerites of the mesonotum lighter gray with a conspicuous median brown line. Pleura dark brownish gray; dorso-pleural region buffy, suffused with brown. Halteres brown, the base of the stem and apex of each knob paler.

Legs with the coxæ brownish gray; trochanters brownish yellow; femora brownish yellow, the tips broadly blackened, preceded by a narrow, brighter yellow, subterminal ring; tibiæ obscure yellow, the tips infuscated; tarsi brownish yellow, passing into brown. Wings with a strong brownish suffusion, variegated with darker and pale areas; dark areas in cell *Sc* extensive, only the second pale spot being conspicuous; post-stigmal pale area very small, restricted to cells Sc_2 and base of R_2; a narrow obliterative line across cell *1st* M_2; pale areas in apices of the cells beyond R_2; a conspicuous yellow mark near the outer end of cell *M* adjoining vein Cu_1; veins brown; obliterative areas extensive Venation: R_{1+2} pale but entire, with macrotrichiæ only at base; distal section of vein M_3 arcuated.

Abdomen with the first tergite brown; succeeding tergites yellow, the caudal and sublatera' portions of the segments dark brown, becoming more extensive on the outer segments, the terminal segments uniformly darkened. Male hypopygium relatively small and slender. Ninth tergite extensive, the width subequal to the length, broadest just beyond midlength, thence gradually narrowed; caudal margin with a broad, very shallow emargination; viewed from the side, each lobe with two chitinized black points. Basistyle with the ventro-caudal lobe small, scarcely longer than broad, pale in color, with conspicuous setæ; mesal lobe of about the same size, dark-colored. Outer dististyle relatively small but stout, a little enlarged outwardly, with long, conspicuous setæ. Inner dististyle bifid at apex, the caudal margin near midlength with a conspicuous fringe of pale crenulate setæ. Eighth sternite with a single median appendage, relatively small, the stem portion narrow, at apex dilated into a small flattened head that is bent strongly ventrad, clothed with short silken setulæ. Ventral surface of sternites four to seven with very long conspicuous white setæ, producing a wooly appearance.

Habitat: Argentina (Patagonia). *Holotype*, ♂, Bariloche, L. Nahuel Huapi, April 1922 (A. Merkle); through Dr. Carlos Bruch.

Tipula anthonympha sp. n.

Belongs to the *glaphyroptera* group; allied to *hylonympha* Alexander; mesonotum gray, the praescutum with four entire brown stripes; femora yellow, the tips blackened; wings long and narrow, marbled with brown and gray; abdomen with the intermediate tergites yellow with a broad sublateral black stripe on either side; eighth sternite of male hypopygium with a conspicuous flattened bilobed appendage, the lobules fringed with long conspicuous yellow setæ.

Male. Length about 23 mm. wing, 25 × 5.3 mm.

Frontal prolongation of head dark brown, pruinose above; nasus long and slender; palpi black. Antennæ short, if bent backward ending far before the wing-root; first segment brown, the apex blackened; second segment obscure yellow; flagellum black; first flagellar segment elongate, subequal to the succeeding two taken together; verticils

relatively inconspicuous, shorter than the segments. Head pruinose; vertex with a dark brown median stripe; posterior orbits lined with dark brown.

Mesonotum gray, the praescutum with four entire brown stripes, the intermediate pair narrowed behind; each scutal lobe with two brown areas; posterior sclerites of mesonotum lighter gray with a median brown vitta. Pleura gray with a broad dark brown dorsal stripe extending from the cervical sclerites to the pleurotergite, the ventral portion of the latter almost whitish gray; dorso-pleural region buffy yellow. Halteres obscure yellow, the knobs infuscated. Legs with the coxæ pruinose; trochanters dark brown; femora obscure yellow, the tips broadly blackened, preceded by a vague, narrow, brighter yellow ring; tibiæ obscure yellow, the tips infuscated; tarsi light brown, passing into darker brown at tips; claws small, simple; legs very long and slender. Wings unusually long and narrow, as shown by the measurements; yellowish subhyaline, handsomely clouded and marbled with brown and gray; cells *C* and *Sc* pale yellow, the latter with four relatively small brown areas; the pale area between the second and third dark areas extensive; stigma light brown, bordered by darker brown; all medial, cubital and anal cells marbled with gray, the bases and apices of the cells with pale areas; veins brown, the obliterative areas extensive. Venation: R_{1+2} entire but pale on distal third.

Abdomen with the basal tergites dark brown, the intermediate segments obscure yellow, broadly blackened sublaterally, the lateral margins narrowly pale; terminal segments more uniformly blackened; sternites brownish yellow, the outer segments blackened. Male hypopygium with the ninth tergite extensive but wider than long, the caudal margin with a broad V-shaped median notch. Basistyle small, the ventro-caudal lobe barely evident as a microscopic black lobule that is provided with dark setæ; mesal lobe pale, relatively inconspicuous, clothed with delicate setulæ; neither the basistyle nor its lobes bear long conspicuous reddish setæ, as is the case in *hylonympha*. Outer dististyle pale at base, the apex a little expanded. Eighth sternite with the median appendage broad, conspicuously bilobed, each lobule fringed with very long, conspicuous, yellow setæ.

Habitat: Argentina (Patagonia). *Holotype*, ♂, Bariloche, L. Nahuel Huapi, April 1922 (A. Merkle); through Dr. Carlos Bruch.

Tipula fazi sp. n.

Belongs to the *glaphyroptera* group; antennæ (♂) elongate, basal three segments yellow, remainder of flagellum black; mesonotal praescutum gray with three dark brown stripes, the median stripe weakly divided; pleura partly dark, partly yellow; femora yellow, the tips broadly blackened; claws (♂) with a conspicuous basal tooth; wings suffused with yellow, the dark pattern very reduced; male hypopygium with the ventro-caudal lobe of basistyle very small; no appendage on eighth sternite.

Male. Length about 13 mm.; wing, 15.5 mm.; antenna about 6 mm.

Frontal prolongation of head brownish yellow; nasus long and slender, brownish black; palpi dark brown, the terminal segment pale reddish yellow. Antennæ (♂) unusually long, if bent backward extending to some distance beyond the base of the abdomen; scape and first flagellar segment pale yellow; remainder of flagellum black; first flagellar segment elongate, a little longer than the first scapal; remaining flagellar segments elongate, only gently incised, a little longer than the longest verticils. Head gray, paler behind.

Mesonotal praescutum gray with three dark brown stripes, the median stripe except at posterior end divided by a pale line and further split by a capillary dark brown vitta; scutum gray, each lobe with two brown areas; scutellum gray, paler laterally, with a median brown line; postnotal mediotergite gray with a vague darker median line, the lateral margins narrowly pale. Pleura with the anepisternum and ventral sternopleurite dark, sparsely pruinose; remainder of pleura, including the pleurotergite and dorsal sternopleurite pale; dorsopleural membrane yellowish. Halteres pale, the outer end of the stem and the knobs dark brown, the apices of the latter restrictedly pale. Legs with the coxæ and trochanters yellow, sparsely pruinose; femora yellow, the tips broadly and conspicuously blackened, preceded by a vaguely brighter yellow ring; tibiæ obscure yellow, the tips broadly infuscated; basal two tarsal segments pale, the tips and outer tarsal segments infuscated; claws with a long slender basal tooth. Wings with a yellowish suffusion, the distal third somewhat more infumed; stigma brown, oval; three vague brown clouds in cell *Sc*; anterior cord with a similar scarcely indicated pale brown cloud; post-stigmal pale area including the basal third of cells R_2 and R_3; a narrow white obliterative line in outer end of cell *R* and base of cell *1st* M_2, barely reaching M_4; cell Cu_1 uniformly darkened; vein Cu_1 in cell *M* on distal two-thirds conspicuously seamed with brown, interrupted at near two-thirds the length of the cell; veins dark brown. Venation: Free tip of Sc_2 and R_{1+2} entire, both with macrotrichiæ for entire length; cell *1st* M_2 relatively small, pentagonal.

Abdomen with the basal tergite gray; succeeding tergites yellow with a conspicuous median black stripe and scarcely indicated brown lateral stripes; on the outer segments the black is very extensive, including all of segments seven and eight and most of nine. Male hypopygium small. Ninth tergite large, black, with a large pale basal triangle; lobes abruptly yellow; caudal margin of tergite thin, with a median U-shaped notch, the lateral lobes broad, the apex of each with four or five microscopic denticles. Basistyle relatively small, complete; ventro-caudal lobe very small, subglobular, with conspicuous setiferous tubercles; mesal lobe larger but still inconspicuous, pale, when viewed from beneath subtriangular in outline; neither lobe projecting strongly beyond the genital chamber. Outer dististyle subcylindrical, terete, the outer half with long pale setæ. Eighth sternite unarmed.

Habitat: Chile. *Holotype*, ♂, L. Panguipulli, Valdivia, March 3, 1924 (Alf. Faz). Holotype in U. S. National Museum.

Tipula fazi is named in honor of the collector, Mr. Alfredo Faz.

Tipula spatulifera sp. n.

Belongs to the *glaphyroptera* group; antennæ bicolorous; mesonotal praescutum obscure yellow with three brown stripes; male hypopygium with the appendage of the eighth sternite appearing as a conspicuous median spatula, the blade nearly as wide as long, the dorsal surface with a dense cushion of short setæ.

Male. Length about 14 mm.; wing, 15–15.5 mm.

Frontal prolongation of head yellow, with a narrow darker lateral line; nasus short and stout, with black setæ; palpi brownish black. Antennæ with the scape and basal flagellar segment yellow, the succeeding flagellar segments vaguely bicolorous, the basal enlargement black, the remainder obscure brownish yellow; outer flagellar segments broken; longest verticils subequal to the segments. Head ochreous, the vertex apparently marked with brown

Mesonotal praescutum obscure yellow with three brown stripes, the median stripe entire except in front where it is slightly divided by a pale vitta; scutum grayish laterally, more yellow medially, each lobe with two brown areas; posterior sclerites of mesonotum yellow with a narrow brown median vitta. Pleura variegated obscure yellow and brownish gray, the latter color on the sternopleurite, dorsal and ventral anepisternum, ventral pteropleurite and meron; remainder of pteropleurite clearer yellow with a sparse white pollen. Halteres yellow, the knobs dark brown. Legs with the coxæ obscure yellow, a little darkened at base; trochanters obscure yellow; remainder of legs broken, except the base of the fore femur which is light yellow. Wings with a brownish suffusion, conspicuously variegated with white; cells *C* and *Sc* more yellowish; three brown areas in cell *Sc;* post-stigmal crossband nearly complete; pale marginal spots in cells R_5 to *1st A* inclusive; cell *2nd A* pale.

Abdomen obscure yellow, the tergites trivittate with dark brown, on the outer segments the stripes widened to include most of the segments; subterminal segments blackened; hypopygium with the sternite and basistyle dark, the tergite and appendage of eighth sternite pale. Male hypopygium relatively large. Ninth tergite gently arched, the caudal margin slightly narrowed, with a small U-shaped median notch; lateral lobes truncate, low and broad. Basistyle complete; ventro-caudal lobe relatively long and slender, at least five times as long as thick, with long conspicuous setæ; mesal lobe conspicuous, extended caudad beyond the level of the ventral lobe, appearing as a pale structure that is densely set with microscopic setulæ; viewed ventrally the mesal appendage is seen to be conspicuously tr lobed. Outer dististyle gently enlarged outwardly, with elongate setæ. Inner dististyle compressed, the caudal margin with long pale setæ. Eighth

sternite with a conspicuous median spatulate structure that is nearly as wide as long, the dorsal surface of the blade densely set with a cushion of short erect setæ.

Habitat: Chile. *Holotype*, ♂, L. Panguipulli, Valdivia, February 4, 1924 (Alf. Faz). *Paratopotype*, ♂. Holotype in U. S. National Museum.

Tipula tersa sp. n.

Belongs to the *glaphyroptera* group; antennæ short, bicolorous; mesonotal praescutum striped with brown and gray; wings whitish subhyaline, heavily and conspicuously variegated with brown; post-stigmal white area short and broad, extending into cell R_5; male hypopygium with the mesal lobe of the basistyle very long, approximately twice as long as the ventro-caudal lobe, stout, gently arcuated; appendage of eighth sternite trifid, the median lobe longest.

Male. Length about 16 mm.; wing, 16 mm.

Frontal prolongation of head obscure yellow, darker and slightly pruinose above; nasus elongate; palpi brownish black. Antennæ relatively short, if bent backward ending some distance before the wing-root; scape and basal two flagellar segments obscure yellow, the succeeding flagellar segments bicolorous, the basal enlargement black, the remainder yellow, on the outermost segments becoming more uniform brown; flagellar segments only slightly incised, the basal enlargements small; longest verticils a little exceeding the segments, shorter on the outer segments. Head gray, the vertex a little more brownish gray.

Mesonotal praescutum with the ground-color restrictedly pale brown, with three brown and gray stripes; median stripe chiefly gray, the lateral margins on the posterior two-thirds and a capillary median vitta the entire length dark brown; lateral stripes entire, dark brown, margined with light grey; posterior interspaces pruinose, the setiferous punctures conspicuous, dark brown; lateral and humeral regions of the praescutum of the ground-color; scutum gray, each lobe with two extensive dark brownish gray areas; scutellum pale, the central portion more infuscated; postnotum gray with a dark median vitta. Pleura gray, the dorso-pleural region buffy. Halteres pale, the knobs infuscated. Legs with the coxæ sparsely pruinose; trochanters obscure yellow; femora yellow, weakly and inconspicuously darkened before the tips; tibiæ yellow, the tips infuscated; basitarsi pale, the remainder of the tarsi passing into black. Wings whitish subhyaline, heavily and conspicuously variegated with brown; post-arcular brown mark extensive, reaching the costal margin; three additional brown spots along cell *Sc*, the largest at origin of *Rs;* stigmal area connected with a large cloud on the cord, barely interrupted by a delicate obliterative line across cell *1st* M_2; wing-apex broadly infumed; post-stigmal pale area short and broad, extending from costa into cell R_5; apex of cell R_5 pale; distal ends of cells M_1 to M_3 pale; a conspicuous dark area in the outer end of cell M and most of M_4; both ends of cell Cu_1 darkened; cubital

and anal cells variegated with pale brown and whitish subhyaline; veins brown, obliterative areas extensive. Venation: Distal end of R_{1+2} pale but entire.

Abdomen yellow, the tergites trivittate with dark brown, the median line narrower; subterminal segments more uniformly darkened; hypopygium yellow. Male hypopygium with the ninth tergite extensive, suddenly but slightly narrowed toward caudal end, the caudal margin with a small but very deep U-shaped median notch; lateral lobes obliquely truncated. Basistyle entire, the dorso-apical angle produced, its apex flattened and obtuse; ventro-caudal lobe small, at least four times as long as thick, with very long setæ that are longer than the lobe; mesal lobe very long and conspicuous, directed caudad, fully twice as long as the ventro-caudal lobe, appearing as a pale, gently arcuated structure that is narrowed gradually to the blunt apex, the surface with microscopic setulæ; viewed from beneath, these lobes are seen to be contiguous on basal half, the tips gently divergent. Eighth sternite with the appendage extensive, the basal portion broad; median lobe slender, fully one-half longer than the lateral lobes, the latter a little broader.

Habitat: Chile. *Holotype*, ♂, Bio Bio, January 1928 (A. Pirion).

Tipula microspilota sp. n.

Belongs to the *glaphyroptera* group; general coloration obscure yellow; antennæ bicolorous; mesonotal praescutum with brown stripes, the median stripe trifid; wings with a faint brownish suffusion, the stigma and a small spot on the anterior cord darker brown; male hypopygium with the appendage of the eighth sternite trilobed, all lobes slender, the median lobe a little longer.

Male. Length about 12.5–13 mm.; wing, 15.5–16.5 mm.

Frontal prolongation of head light brown, the nasus elongate. Antennæ with the basal three segments yellow, the succeeding segments bicolorous, the basal enlargement of each black, the remainder yellow; outer segments more suffused; flagellar segments relatively long, the longest verticils nearly equal to the segments. Head gray.

Mesonotal praescutum obscure yellow, with dark brown stripes, the median stripe trifid by a capillary yellow vitta on either side of the subequal median brown line; setigerous punctures conspicuous; scutum gray, the lobes variegated with brown; scutellum yellowish testaceous, brown medially; postnotum light gray, darker medially. Pleura yellow ocherous, more grayish pruinose in fully-colored specimens. Halteres dark brown, the base of the stem pale. Legs with the coxæ and trochanters concolorous with the pleura; femora brownish yellow, the tips scarcely darkened; tibiæ brownish testaceous, the tips scarcely darkened; tarsi passing into pale brown. Wings with a brownish yellow suffusion, the stigma and a small area on the anterior cord darker; obliterative areas before and beyond the stigma and across cell *1st* M_2 barely evident; veins dark brown. Venation: Petiole of cell M_1 longer than *m*.

Abdomen obscure brownish yellow, the tergites trivittate with dark brown, on the subterminal segments appearing as a blackened ring; hypopygium conspicuously yellow. Male hypopygium with the ninth tergite extensive, the caudal margin subtruncate, on either side of the median area a little produced; dorso-median region of tergite channeled; apex of tergite glabrous. Basistyle with the ventro-caudal lobe relatively short and stout, approximately three times as long as thick, tufted with long yellow setæ that exceed the lobe in length; mesal lobe relatively small, the mesal face of each with a brush of long curved reddish setæ that are decussate across the median region of the genital chamber. Eighth sternite with the appendage trilobed, the median lobe slender, a little longer than the lateral lobes; lateral lobes narrow, only a trifle wider than the median lobe, at base on mesal margin a little dilated and darkened, toward the tips a trifle narrowed and incurved to the median lobe.

Habitat: Chile. *Holotype*, a teneral ♂, Malleco, January 1928 (A. Pirion). *Paratype*, ♂, L. Panguipulli, Valdivia, February 1924 (Alf. Faz); U. S. National Museum.

Holorusia Loew.

Holorusia schineriana sp. n.

Allied to *H. concinna* (Philippi); mesonotal praescutum with four blackish stripes that are narrowly margined with velvety-black; wings with the costal region yellow; wing-apex broadly brown, variegated with white areas before and beyond the stigma and at outer end of cell *1st* M_2; male hypopygium with the median notch of the ninth tergite unusually wide.

Male. Length about 15–16 mm.; wing, 18–19 mm.

Frontal prolongation of head brownish black, paler laterally; palpi black. Antennæ black throughout, the second scapal segment brighter at apex; terminal segment very slender, about one-third longer than the penultimate. Head obscure fulvous, the vertex with a capillary brown median line.

Mesonotum yellowish gray, the praescutum with four blackish stripes that are narrowly margined with deeper velvety-black, the posterior interspaces more obscure; scutellum brownish black; postnotum dark, with a yellowish gray pollen. Pleura black, with pruinose areas on the dorsal sternopleurite and meron; pteropleurite more reddish brown; ventral protuberance of the pleurotergite with a golden-yellow pollen; dorso-pleural region buffy yellow. Halteres dark brown, the base of the stem narrowly brighter. Legs with the coxæ dark brown, sparsely yellowish gray pruinose; femora brownish yellow, the tips blackened; tibiæ obscure yellow, the bases and tips infumed; tarsi brownish black. Wings with cells *C* and *Sc* yellow; distal third of wing brown, the stigma still darker brown; whitish areas before and beyond the stigma and in the bases of cells *2nd* M_2 and M_3; distal section

of Cu_1 and outer end of vein *2nd A* seamed with darker brown; prearcular region darkened in part; veins dark brown, the costal veins more yellowish. Venation: Cell M_1 more than twice its petiole; cell *1st* M_2 relatively narrow.

Abdomen black, the intermediate portions of the basal sternites weakly reddish; caudal and lateral margins of the segments very narrowly pale; hypopygium dark, the styli obscure yellow. Male hypopygium with the lateral lobes of the ninth tergite relatively narrow, the tips a little narrowed and slightly divergent, the median notch wide, at outer end only a little narrower than the lobes themselves. Outer dististyle unusually long and slender, extending to some distance beyond the end of the inner dististyle.

Habitat: Chile. *Holotype*, ♂, Marga-marga, February 20, 1927 (A. Pirion). *Paratopotypes*, 1 ♀, September 17, 1927; 1 ♂, 1 ♀, February 14, 1928; 1 ♂, February 25, 1927; 1 ♀, January 25, 1928 (A. Pirion).

This distinct species of the *concinna* group is named in honor of the eminent Dipterologist, J. R. Schiner.

Limonia Meigen.

Limonia (Limonia) **praeclara** sp. n.

General coloration yellow; anterior vertex silvery-white; legs black, the tips of the tibiæ and central portions of the tarsi white; wings with a rich brownish suffusion, sparsely spotted and seamed with dark brown.

Male. Length about 8 mm.; wing, 9.5 mm.

Rostrum very reduced, obscure yellow; palpi short, brownish black, 3-segmented, the second segment longest. Antennæ black throughout; basal flagellar segment enlarged, the outer segments becoming more elongate and attenuate, with long conspicuous verticils; terminal segment slender, more than one-half longer than the penultimate. Head obscure yellow, the anterior vertex with a silvery-white pruinosity; a narrow dusky line crosses the vertex opposite the posterior angles of the eyes.

Thorax with an obscure yellow dorso-median longitudinal stripe, extending from the pronotum to the abdomen, much narrower and less distinct on the postnotum; praescutum with the lateral stripes less distinct, crossing the suture onto the antero-lateral portions of the scutal lobes; interspaces of the praescutum more infuscated; posterior sclerites of mesonotum more or less infuscated. Pleura yellow; sternopleurite with a few scattered setæ. Halteres of moderate length, infuscated. Legs with the coxæ and trochanters yellowish testaceous; femora dark brown; tibiæ black, the tips broadly and conspicuously white; tarsi black, the tips of the basitarsi and segments two and three white; outer tarsal segments darkened; claws long and slender, each with a basal and a premedial slender spine. Wings with a rich brownish suffusion, with a sparse but conspicuous darker brown pattern; con-

spicuous circular areas at origin and fork of *Rs* and at stigma; small restricted seams on Sc_2, along cord and outer end of cell *1st* M_2; veins dark brown. Venation: *Sc* relatively long, Sc_1 ending at near two-thirds the length of *Rs*, Sc_2 at its tip; *Rs* angulated and short-spurred at origin; free tip of Sc_2 a short distance beyond R_2; cell *1st* M_2 large, the inner end more or less arcuated; *m-cu* near fork of *M*, longer than the distal section of Cu_1.

Abdominal tergites dark brown, with a median yellow stripe on the basal segments; outer segments and hypopygium darkened; basal sternites obscure yellowish, the outer segments darkened. Male hypopygium with the ninth tergite low, much wider than long, the caudal margin gently emarginate, each lobe short, with conspicuous setæ. Basistyle with the ventro-mesal lobe large, obtuse. Ventral dististyle smaller than the basistyle, fleshy, bilobed, the dorsal dististyle lying in the notch between the lobes; rostral prolongation slender, nearly glabrous, without distinct spines. Dorsal dististyle a powerful chitinized rod, the tip strongly curved to an acute point; stem of the style microscopically roughened. Gonapophyses conspicuously flattened, the mesal apical angle produced into a slender lobe.

Habitat: Argentina. *Holotype*, ♂, Iguazu Falls, October 3-5, 1927 (R. and E. Shannon).

Holotype in U. S. National Museum.

Limonia (Limonia) **repanda** sp. n.

General coloration yellow; antennal flagellum pale; mesonotal praescutum with a narrow brownish black median stripe on the anterior half; wings yellow, sparsely marked with brown; *Rs* square or even slightly acute at origin.

Male. Length about 5 mm.; wing, 6.2 mm.

Female. Length about 5.5 mm.; wing, 6 mm.

Rostrum and palpi black. Antennæ with the basal segment black, the second segment brown; flagellum pale yellowish white; flagellar segments subglobular, the outer segments passing into oval. Head obscure brownish yellow, the anterior vertex more silvery.

Pronotum black. Mesonotum yellow, the praescutum with a single narrow brownish black median stripe on the anterior half; postnotal mediotergite with a conspicuous brown median area that is narrowed to a point behind. Pleura yellow. Halteres relatively short, greenish testaceous. Legs with the coxæ yellow; trochanters greenish; remainder of legs pale, more or less tinged with greenish, the terminal tarsal segments a little darker. Wings yellow, the base and costal region brighter yellow; a sparse but conspicuous brown pattern, distributed as follows: An oblique seam from costa at Sc_1, across the base of *Rs* almost to *M;* narrow seams on the posterior cord and outer end of cell *1st* M_2; narrow seams on the free tip of Sc_2 and R_2; apices of veins M_3, M_4 and *1st A* narrowly seamed with brown; vein *2nd A* with a conspicuous brown seam on distal third; veins yellow, darker in the infuscated areas. Venation: *Sc* of moderate length only, extending a short distance

beyond the origin of *Rs*, Sc_2 at its tip; *Rs* rectangular or even bent at a slight acute angle at origin; free tip of Sc_2 and R_2 in alignment; *m-cu* at fork of *M*, longer than the distal section of Cu_1; vein *2nd A* short, subangularly bent before apex.

Abdomen yellow. Male hypopygium with the ventral dististyle large and fleshy, the rostral prolongation flattened, bearing two small, subequal, gently curved spines that are placed rather close together at near midlength of the caudal margin. Ovipositor with the valves slender, the tergal valves gently upcurved.

Habitat: Ecuador. *Holotype*, a teneral ♂, Pallatanga, altitude 4400 feet, March 26, 1922 (G. H. H. Tate). *Allotopotype*, ♀, March 31, 1922.

Limonia (Peripheroptera) **incommodes** sp. n.

Male. Wing, 5.2 mm.

Very similar to *L.* (*P.*) *incommoda* (Osten Sacken), differing as follows: Size smaller. Coloration shiny brownish black. Wings hyaline, the tip not darkened; stigma less distinct. Venation: *Sc* short, Sc_1 ending far before the origin of *Rs*, the distance about equal to *m-cu; Rs* longer than the basal deflection of R_{4+5}; basal deflection of M_{1+2} about three times *r-m;* petiole of cell M_3 shorter than the cell; *m-cu* fully its own length before the fork of *M*.

Habitat: Peru. *Holotype*, a broken ♂, Tambillo, 1895. Holotype in the Natural History Museum, Vienna.

Limnophila Macquart.

Limnophila seclusa sp. n.

General coloration ferruginous, the praescutum with a median brown stripe on anterior half; head pruinose; wings yellowish, the stigma and a seam on the cord very pale brown; R_2 near the fork of R_{3+4}; *m-cu* at or beyond midlength of cell *1st* M_2.

Female. Length about 9.5–10 mm.; wing, 8.6–9 mm.

Rostrum obscure yellow; palpi dark brown. Antennæ with the scapal segments testaceous yellow, the first segment relatively short; flagellum broken. Head brown, pruinose, light gray on the anterior vertex and posterior vertex; head strongly narrowed behind.

Pronotum brownish yellow to ferruginous brown. Mesonotum reddish brown, the praescutum with a single black median stripe on anterior half. Pleura reddish ferruginous. Halteres pale, the knobs slightly infuscated. Legs with the coxæ concolorous with the pleura; trochanters obscure yellow; remainder of legs broken. Wings with a yellowish ground-color, the stigma pale brown; cord vaguely seamed with pale brownish; veins darker brown. Venation: Sc_1 ending opposite the fork of *Rs*, Sc_2 at its tip; R_2 variable in position, in the type before the fork of R_{3+4}, in the paratype beyond this fork on R_3, a little shorter than R_{1+2}; cell M_1 present, much shorter than its petiole; *m-cu* near or beyond midlength of cell *1st* M_2; vein *2nd A* gently sinuous.

Abdomen relatively long and slender; tergites brown, the sternites more yellowish. Ovipositor with the valves relatively long, the tergal valves gently upcurved.

Habitat: Chile. *Holotype*, ♀, Pailahueque, Malleco, January, 1928 (A. Pirion). *Paratopotype*, ♀.

Limnophila litigiosa sp. n.

General coloration dark brown; pleura sparsely pruinose; wings with a cream-colored ground, sparsely variegated with pale brown, including the stigma and vague seams along the cord and vein *Cu*; R_2 at fork of R_{3+4}; cell M_1 present but small; *m-cu* close to the fork of *M*.

Female. Length about 9 mm.; wing, 9 mm.

Rostrum and palpi brown. Antennæ relatively short; scape black; flagellum dark brown; flagellar segments a little produced on the lower face. Head dark brown, sparsely pruinose.

Pronotum dark brown. Mesonotum brown, the praescutum with a somewhat darker median stripe, the surface with a very sparse yellowish pollen; scutellum broad, paler brown. Pleura and postnotum dark, with a sparse grayish pruinosity. Halteres pale yellow. Legs with the coxæ and trochanters brownish testaceous; femora yellowish brown, the tips somewhat darker; tibiæ pale brown, the tips scarcely darkened; tarsi pale brown; tibial spurs small. Wings cream-colored, with a sparse brown pattern; stigma oval; vague clouds at origin of *Rs*, along cord and as a seam along vein Cu_1; veins pale brown. Venation: *Sc* relatively short, Sc_1 extending to opposite the fork of *Rs*, Sc_2 a short distance from its tip; R_2 at fork of R_{3+4}, a little shorter than R_{1+2}; R_3 and R_4 rather strongly diverging; cell R_3 at margin nearly twice as wide as cell R_2; cell M_1 present, less than one-half its petiole; *m-cu* close to the fork of *M*.

Abdomen light brown, the outer segments somewhat darker; genital segment yellowish. Ovipositor with the valves relatively short, the tergal valves yellow, gently upcurved; sternal valves subequal, blackened at base.

Habitat: Chile. *Holotype*, ♀, Marga-marga, February, 1928 (Jaffuel and Pirion).

I am not entirely certain that this fly is not more correctly referable to the subgenus *Paralimnophila* of *Gynoplistia*. The venation of both wings of the type is deformed in cell R_5 and in the medial field, there being two adventitious cross-veins in cell R_5 in each wing but in different positions on the two sides.

Gynoplistia Westwood.

Gynoplistia (Paralimnophila) **pachyspila** sp. n.

Antennæ simple; mesonotal praescutum yellowish gray with three heavy brown stripes; a conspicuous brownish black longitudinal stripe

on the dorsal thoracic pleura; femora yellow, with two brownish black rings, the broadest terminal in position; wings narrow, heavily spotted and dotted with brown; cell *2nd A* narrow.

Male. Length about 9 mm.; wing, 8.2 × 1.6 mm.

Rostrum and palpi dark brown. Antennæ with the scapal segments obscure yellow, sparsely pruinose; flagellum broken. Head brownish gray, clearer gray in front, the anterior vertex with an obscure yellow area; a broad dark brown median stripe on the posterior vertex and occiput.

Pronotum gray, with a dark median line. Mesonotal praescutum yellowish gray with a conspicuous dark brown pattern, including three stripes that are so extensive as to reduce the interspaces to capillary lines; humeral region restrictedly darkened; a brownish black lateral marking crosses the suture onto the lateral portions of the scutal lobes; pseudosutural foveæ very large, black; posterior sclerites of mesonotum golden-yellow, heavily marked with dark brown, including the scutal lobes and a nearly continuous dark line from the suture to the abdomen. Pleura yellowish gray, with a broad brownish black longitudinal stripe from the pronotum, across the dorsal pleurites to the postnotum; sternopleurite less distinctly darkened. Halteres pale, the knobs brownish black. Legs with the coxæ yellowish gray, the tips ringed with brown; trochanters obscure yellow; femora yellow, with the tip and a narrower ring at about two-thirds the length brownish black, enclosing a clearer yellow annulus; remainder of legs broken. Wings narrow, as shown by the measurements; ground-color creamy-yellow, the base and costal region clearer yellow; stigma oval, dark brown; cells *C* and *Sc* variegated with three subequal dark brown areas, the second at origin of *Rs*, the third at Sc_2; a large area at end of vein R_3; remaining surface of the wing with abundant brown dots and spots in all the cells; veins dark brown, the costal, subcostal and radial veins more yellowish. Venation: R_{2+3+4} very short but evident; cell *2nd A* very narrow, especially on the basal half, the anal lobe very reduced.

Abdomen brownish black, including the small hypopygium; sternites testaceous yellow, the caudal margins of the segments ringed with dark brown.

Habitat: Chile. *Holotype*, ♂, Malleco, January, 1928 (A. Pirion).

Aphrophila Edwards.

Aphrophila chilena sp. n.

General coloration yellow; antennæ black, the scape yellow; legs yellow, the tips of the femora and tibiæ slightly darkened; wings whitish subhyaline, the stigma and axillary region infumed; R_2 opposite or shortly before the fork of R_4; cell *1st* M_2 closed; male hypopygium with the apex of the dististyle quadridentate.

Male. Length about 4.5–6 mm.; wing, 6–7 mm.

Female. Length about 5.5–6.5 mm.; wing, 5.5–7.5 mm.

Rostrum yellow; palpi brownish black. Antennæ with the scape yellow; flagellum black; flagellar segments short-oval, crowded. Head brownish yellow.

Mesonotal praescutum yellow with four deep fulvous stripes; scutum similar, each lobe with fulvous markings; scutellum yellow; postnotum somewhat darker. Pleura light fulvous to ochreous. Halteres pale yellow throughout. Legs with the coxæ concolorous with the pleura; trochanters yellow; remainder of legs yellow, the tips of the femora and tibiæ insensibly darkened; terminal tarsal segments passing into dark brown. Wings whitish subhyaline; stigma small, pale brown; a conspicuous brown wash in the axillary region; veins pale, veins R_1 and R_5 somewhat darker in color. Venation: Sc_2 close to the tip of Sc_1; Rs of moderate length, subequal to R_{2+3+4}; R_2 subequal to R_{1+2}, placed at or shortly beyond the point of departure of R_4; R_{3+4} in alignment with R_{2+3+4} and R_3; cell *1st* M_2 closed; *m* much shorter than the basal section of M_3; *m-cu* close to the fork of M; cell *2nd A* very large.

Abdomen brownish yellow, in the male with the subterminal segments brownish black; hypopygium large, fulvous-yellow. Male hypopygium with the basistyles very large and powerful, as in the group; dististyle as in the genus, single, appearing as a powerful compressed blade, the apex quadridentate, the outer margin on basal half with long retrorse setæ. Ovipositor with the valves short and powerful, as in the genus; a pencil of setæ on either side, dorsad of the valves.

Habitat: Chile. *Holotype*, ♂, Province of Bio Bio, January 1928 (A. Pirion). *Allotype*, ♀, Pailahueque, January, 1928 (A. Pirion). *Paratopotypes*, ♂ ♀; *paratypes*, 7 ♂ ♀, with the allotype.

The discovery of a species of *Aphrophila* in Chile is of the greatest importance and significance in supporting the contention of a former Antarctic land-connection between southern South America and Australasia. The genus was hitherto represented only by eight species in New Zealand, where certain of the forms are common and relatively well-known. The adult flies are very similar in their habits to the Blepharoceridæ, being found close to the margins of mountain torrents, often on the faces of rocks that are wet with spray, whence the name of "Foam-loving Crane-flies." As was the case with the finding of the net-winged midge, *Edwardsina*, spp., in Australia and Tasmania, following their original discovery in Chile, the present detection of *Aphrophila*, with its restricted larval habitat in fresh, fast-flowing streams, would compel us to presuppose an extensive and rugged Archinotis, rather than a tenuous finger of land of low altitudes.

HYPERALONIA OENOMAUS ROND., A PARASITE OF TIPHIA LARVÆ (DIP., BOMBYLIIDÆ).*

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INTRODUCTION.

During the summer of 1925 at Shillong, India, field collections of cocoons of a large species of *Tiphia* parasitic upon the grubs of *Anomala dimidiata* Hope were observed to be heavily parasitized by a Bombyliid fly. A number of these were reared out and later forwarded to the National Museum for examination, and have been determined as *Hyperalonia oenomaus* Rond., by Dr. J. M. Aldrich. The overwintering cocoons of the 1925 generation of *Tiphia* were attacked to the extent of more than sixty per cent, and the effectiveness of this scoliid upon its host was thereby greatly reduced. Little information is available in literature upon the biology of this group of flies, but inasmuch as several other species were present in small numbers in the cocoons of various species of *Tiphia* that were being imported for the control of the Japanese beetle (*Popillia japonica* Newm.) it was felt desirable to make a study of the more common *Hyperalonia* from the point of view of the relation of the habits of this family of parasitic flies to the methods of parasite breeding and importation at present in use.

THE LIFE CYCLES OF TIPHIA AND HYPERALONIA.

In Figure 1 is given a representation of the life cycles of *Tiphia* and its parasite, *Hyperalonia oenomaus*. The observations recorded in this study were upon a single species of *Tiphia* (author's No. 2037) normally parasitic exclusively upon the grubs of *Anomala dimidiata*. The winter is passed in the mature larval stage in cocoons in the soil. Adults begin to emerge at the end of May and attain the maximum numbers by the tenth of June. The last adults of the normal single generation persist in the field until about the twentieth of

* Contribution No. 42 of the Japanese Beetle Laboratory, Moorestown, N. J.

July. Thereafter until the end of September an occasional wasp may be found, these apparently comprising a partial second generation, but in such small numbers as not to effect the conclusions reached. The early stages cover approximately the same period of time as those of other *Tiphia*, the eggs hatching in four to six days under summer temperatures and the larval stages requiring fifteen to twenty days for the completion of feeding.

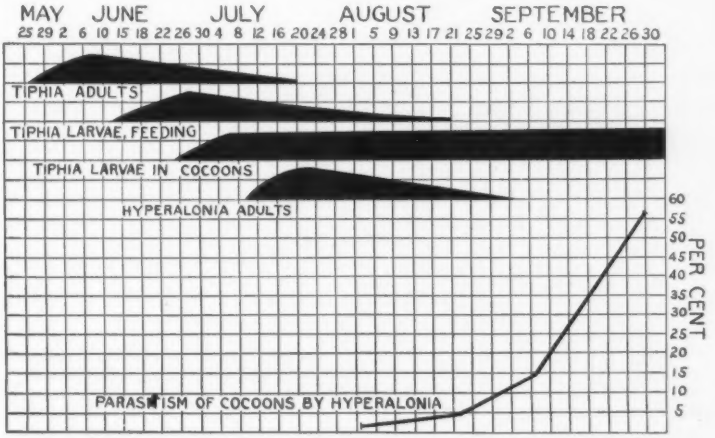

FIG. 1. Diagrammatic calendar showing the periods covered by *Tiphia* and *Hyperalonia*, with the curve indicating the percentage of cocoons parasitized on successive dates.

Hyperalonia has a single generation each year and passes the winter in the mature larval stage in the cocoon of its host. Pupation occurs the middle of June and the first adults appear in the field about the tenth of July, with the maximum numbers attained within ten days thereafter. Adult life extends over about six weeks and the last females are found during the first few days of September. Thus the period of adult presence of *Hyperalonia* in the field is from five to six weeks later than that of its host, and only a few *Tiphia* are to be found at the time the parasite begins to emerge. In fact the greater proportion of *Tiphia* larvæ have already spun their cocoons before the *Hyperalonia* appear, and this is completed for the normal

generation by August 20. Were the percentage of parasitism very low it might be asserted that the individuals developing beyond the normal period were the ones attacked, but with a total parasitism exceeding sixty per cent, this cannot be the case.

FIELD COLLECTIONS OF TIPHIA.

During the season of 1926 a series of collections of the immature stages of *Tiphia* upon *Anomala* grubs, as well as of cocoons already formed, was made at intervals throughout the period when parasitism was possible by *Hyperalonia*. The data secured from these collections are tabulated below under their respective dates, and reveal the progress of parasitism of *Tiphia* by *Hyperalonia* from the first individuals to the end of the season.

FIELD COLLECTIONS OF TIPHIA.

MARCH 17, 1926.

Overwintering cocoons:	
Total cocoons collected	150
Cocoons containing *Tiphia* larvæ	50
Cocoons containing *Tiphia* pupæ	2
Cocoons containing *Hyperalonia* larvæ	98
Percentage of parasitism	65.3%

JULY 3, 1926.

Overwintering cocoons:	
Total cocoons collected	96
Empty cocoons, *Tiphia* emerged	25
Cocoons containing *Tiphia* larvæ or pupæ	10
Cocoons containing *Hyperalonia* larvæ	1
Cocoons containing *Hyperalonia* pupæ	60
Empty cocoons, *Hyperalonia* emerged	0
Percentage of parasitism	63.5%
New Generation. (Examined September 15).	
Tiphia, egg stage	19
Tiphia, larval stage, feeding	129
Tiphia, larvæ in cocoons	68
Tiphia cocoons containing *Hyperalonia* larvæ	0
Percentage of parasitism	.0%

JULY 15, 1926.

Overwintering cocoons:	
Total cocoons collected	171
Empty cocoons, *Tiphia* emerged	60
Cocoons containing *Tiphia* pupæ or adults	3
Empty cocoons, *Hyperalonia* emerged	60
Cocoons containing *Hyperalonia* pupæ	48
Percentage of parasitism	63.2%

New Generation. (Examined September 30).

Tiphia, egg stage	4
Tiphia, larval stage, feeding	54
Tiphia, larvæ in cocoons	63
Tiphia cocoons containing *Hyperalonia* larvæ	0
Percentage of parasitism	.0%

AUGUST 2, 1926.

Overwintering cocoons:

Total cocoons collected	118
Empty cocoons, *Tiphia* emerged	50
Empty cocoons, *Hyperalonia* emerged	68
Cocoons containing *Tiphia*	0
Cocoons containing *Hyperalonia*	0
Percentage of parasitism	57.6%

New Generation. (Examined October 1).

Tiphia, egg stage	4
Parasitized by *Hyperalonia*	0
Tiphia, larval stages, feeding	21
Parasitized by *Hyperalonia*	0
Tiphia cocoons	158
Containing *Tiphia* larvæ	131
Containing *Tiphia* larvæ, dead	20
Containing *Tiphia* pupæ	2
Containing *Tiphia* adults	2
Containing *Hyperalonia* larvæ	3
Percentage of parasitism	1.9%

AUGUST 22, 1926.

New Generation. (Examined October 3).

Tiphia, egg stage	0
Tiphia, larval stages, feeding	28
Parasitized by *Hyperalonia*	0
Tiphia cocoons	200
Containing *Tiphia* adults	3
Containing *Tiphia* larvæ	188
Containing *Hyperalonia* larvæ	9
Percentage of parasitism	4.3%

SEPTEMBER 7, 1926.

New Generation. (Examined October 8).

Tiphia, larval stage, feeding	7
Parasitized by *Hyperalonia*	0
Tiphia cocoons	217
Containing *Tiphia* adults	7
Containing *Tiphia* pupæ	6
Containing *Tiphia* larvæ	173
Containing *Hyperalonia* larvæ	31
Percentage of parasitism	14.3%

SEPTEMBER 30, 1926. (Examined October 15).

New Generation.

Tiphia cocoons	167
Containing *Tiphia* adults	8
Containing *Tiphia* pupæ	27
Containing *Tiphia* larvæ	38
Containing *Hyperalonia* larvæ	94
Percentage of parasitism	56.3%

RÉSUMÉ.

FIELD COLLECTED MATERIAL, 1925 GENERATION.

	Mar. 17	July 3	July 15	Aug. 2
Tiphia cocoons collected	150	96	171	118
Containing *Tiphia* larvæ	50	2	0	0
Containing *Tiphia* pupæ	2	8	2	0
Containing *Tiphia* adults	0	0	1	0
Containing *Hyperalonia* larvæ	98	1	0	0
Containing *Hyperalonia* pupæ	0	60	48	0
Empty, *Tiphia* emerged	0	25	60	50
Empty, *Hyperalonia* emerged	0	0	60	68
Percentage of parasitism	65.3%	63.5%	63.2%	57.6%

FIELD COLLECTED MATERIAL, 1926 GENERATION.

	July 3	July 15	Aug. 2	Aug. 22	Sept. 7	Sept. 30
Parasit. grubs collected, set aside for development	148	58	25	8	7	0
Number parasitized	0	0	0	0	0	0
Tiphia larvæ in cocoons	68	63	158	200	217	167
Cocoons parasitized	0	0	3	9	31	94
Percent of parasitism	.0%	.0%	1.9%	4.5%	14.3%	56.3%

FIELD PARASITISM OF TIPHIA BY HYPERALONIA.

Four field collections of *Tiphia* cocoons were made in the spring and early summer of 1926 to determine the percentage of parasitism of overwintering cocoons by *Hyperalonia*, the first, on March 17, comprising 150 cocoons, of which 98, or 65.3 per cent were found to contain mature *Hyperalonia* larvæ. The second collection, of 96 cocoons, was made July 3, and of this number one was found to contain a *Hyperalonia* larva and 60 contained pupæ, a parasitism of 63.5 per cent. None had emerged on this date. On July 15, 171 cocoons were obtained, 48 of which contained *Hyperalonia* pupæ and 60 had already emerged, a total parasitism of 63.2 per cent. The final observation was made on August 2, when 118 cocoons were collected, from 68 of which *Hyperalonia* had emerged, revealing a parasitism of 57.6 per cent.

In the case of the new generation of *Tiphia* developing upon grubs during June, July and August, the primary point under consideration was the time at which the parasite gained access to its host. Whether this took place upon the feeding larva on the grub or whether entrance was effected through the cocoon had not been noted in the studies upon other species. A consideration of the times of appearance and the life cycles of *Hyperalonia* and its host, as shown in Figure I, indicated that

this was probably accomplished after the cocoon had been spun. To verify this point collections were made periodically from July 3 to September 30, and the collectors were instructed to bring in all parasitized *Anomala* grubs of whatever stage, and all *Tiphia* cocoons as well. It was possible to distinguish between cocoons of the current season's production and those of the preceding generation by their lighter color and less weathered condition. The records made at the time of collection were only of the stage attained by the *Tiphia* at that date.

As the primary larvæ of *Hyperalonia* are quite small and might easily be overlooked in examining the grubs, the detailed examination was not attempted at the time of collection, but instead the parasitized grubs were set aside in individual tins and allowed to remain therein until sufficient time had elapsed for such *Hyperalonia* larvæ as they bore, if any, to complete feeding and to attain the mature larval stage. The cocoons were then cut open and the contents noted. This then gave the percentage of parasitism attained for each lot upon the date of collection. The cocoons collected at the same time were likewise set aside for the parasites to develop, and examination was upon the same dates as that of the earlier stages above mentioned.

The collection of July 3 yielded 148 grubs bearing *Tiphia* eggs or feeding larvæ, that of July 15, 58 in the same stages, that of August 2, 25 larvæ, of August 22, 28 larvæ and of September 7, 7 feeding larvæ. Thus during the period covered a total of 266 grubs bearing the early stages of *Tiphia* were collected and set aside for development. The cocoons obtained from these collections were examined between September 15 and October 8, and not a single one showed evidence of parasitism by *Hyperalonia*. Had they been present they would have been in the mature larval stage and easily recognizable at the time of examination. This result confirmed the conclusion previously reached, that *Hyperalonia* does not gain access to its host prior to the formation of the cocoon.

Of the field-collected cocoons of the summer generation, 68 were obtained on July 3, 63 on July 15, 158 on August 2, 200 on August 22, 217 on September 7 and 167 on September 30. The collection of July 3 material yielded no *Hyperalonia*, as the parasite adults had not then emerged. That of July 15 likewise showed no parasitism. The August 2 collection

yielded 3 parasitized cocoons, or a percentage of 1.9 per cent for that date. The following lot, collected August 22, contained 9 parasitized cocoons, or 4.5 per cent. From this date onward the greater proportion of parasitism was effected On September 7, 31 cocoons, or 14.3 per cent of the total number secured on that date, were parasitized. The September 30 collection of 167 cocoons showed 94, or 56.3 per cent, as being parasitized. This approximated the parasitism of the preceding year, when a series of five collections at various dates, totaling 835 cocoons, reached an average parasitism of 59.3 per cent. From the above it may be concluded that the maximum parasitism was effected in the cocoons between August 22 and September 30, at which times only an occasional feeding *Tiphia* larva was to be found. The rise in the parasitism curve, as shown in Figure 1, is very sharp after September 7. As the last *Hyperalonia* adults were to be found in the field about September 4 it would appear that the period spent by the primary larva in the soil in the search for the host cocoons is relatively long.

LIFE HISTORY OF HYPERALONIA OENOMAUS.

The Adult. As previously pointed out the adults of this species first appear in the field about July 10 and persist until early September, with the maximum number present late in July. Because of the pressure of other work at this time it was not possible to make extended observations upon the habits of the adults. They were found flying most generally during mid-day in bright sunshine, and feeding at various flowers. In the infested area females were often seen flying just above the surface of the ground and at times resting upon the grass blades. It is probable that the eggs are laid either upon the soil surface or dropped there during flight, a habit said by authors to occur in other species. In certain of these cases the female has been recorded as dropping the eggs in the immediate vicinity of the host burrow or nest, but whether this is the case with *Hyperalonia*, or whether they are scattered indiscriminately upon the surface, could not be determined.

Dissections of females at various periods after emergence indicated that the period of gestation covers about two weeks, which corresponds to that of various other of the larger parasitic flies, notably the Tachinidæ. A gravid female when dissected showed a total of 537 apparently mature eggs in the ovisac. These were slightly brownish in color, ellipsoidal in form and 0.5 mm. in length. This is the largest number noted in the body of any of the females examined, and is relatively small when the potential mortality of the first larval stage is considered. The length of life of the female, however, is relatively long and the aggregate of eggs laid may be many times the above number.

The First Larval Stage.—(Fig. 2). An extended examination of *Tiphia* cocoons during several seasons finally resulted in the finding of two first-stage larvæ of *Hyperalonia* in September, 1927. From their relative scarcity as compared with the other stages present it would appear that the duration of the stage is very short once the host larva is reached.

This primary larva, equipped with a heavily chitinized head and body, and similar in general form to the first stage larva of the Dexiidæ (6), is under the necessity of searching about in the soil for the cocoons of its host. In the area in which the parasite is most common the soil is very light and sandy and thus easy of penetration by the vermiform *Hyperalonia* larva. What takes place during the time the search goes on can only be surmised, but it is probable that the minute parasite larva is capable of determining to some extent the location of its host, and this is more probable than the ability of the female fly to locate the *Tiphia* cocoons one to three inches beneath the surface of the soil. While some of the larvæ may gain almost immediate access to cocoons, yet by far the greater proportion are under the necessity of making a prolonged search. If it is assumed that the egg stage covers only a few days then, from the date available upon the time of adult presence in the field and the dates upon which the relative percentages of parasitism are effected, the conclusion may be drawn that from one to three weeks are spent in the soil in this search.

Having once located the cocoon the next problem is to penetrate it and reach the larva contained therein. From what is known of the capabilities of penetration of various dipterous larvæ of similar habit, this should not be a difficult matter, as the cocoon wall is comparatively light as compared with the heavily chitinized body wall of the hosts which some Tachinidæ and Dexiidæ penetrate. Entrance having been effected, feeding begins almost immediately, largely in the thoracic region, and from a length of approximately 0.9 mm. the larva grows to nearly 2.0 mm. before moulting. Movement takes place frequently during the feeding period, the slender body of the larva enabling it to crawl about in the intersegmental crevices with ease. Even the feeding by this small larva has a noticeable effect upon the host, the latter losing its fresh, glistening color and becoming slightly grayish and somewhat flaccid.

Second Larval Stage.—(Fig. 3). This larva measures 2.7 to 3.5 mm. in length, dependent upon the amount of feeding which has taken place, and is much more robust than the preceding stage. The heavily chitinized head is lacking, as are also the pairs of long setæ upon the thoracic segments and at the caudal end of the body. In this stage also the larva is capable of free movement within the cocoon, and feeding punctures are visible in considerable numbers upon the derm of the host larva, largely in the thoracic region but also to some extent upon the abdomen.

Third Larval Stage.—(Fig. 4). The final larval stage is very similar in general appearance to the preceding one, though with the segmentation not so pronounced, and with the thoracic segments slightly yellowish

and the abdomen milky white, due to the large and numerous fat bodies visible through the derm. Development is rapid in this stage and the body contents of the host are completely sucked out, leaving only the shrunken skin and head as a pad at the posterior end of the cocoon. In the dormant condition this larva lies with its head at the anterior end of the cocoon, and with both ends of the body curved ventrally. Thus the winter and spring are passed and pupation occurs late in June.

The Pupal Stage. The pupa within the host cocoon is capable of limited movement therein, but is usually quiescent unless disturbed. In form it is similar to those of other species of Bombyliidæ which have been described. Just prior to the time of emergence of the fly the pupa becomes very active, and by a rolling movement within the cocoon finally succeeds in cutting a circular cap from the anterior end, using for this purpose the sharp prongs upon its head. When free from the cocoon the pupa works itself to the surface of the soil, where it remains for a short time with the head exposed. Emergence from the pupal envelope is usually during the early morning hours, and is effected by a dorsal split extending from the rear margin of the head to the prong crown, and laterally from this point around the head to near the base of the median ventral prong.

The *Tiphia* cocoons from which *Hyperalonia* larvæ have emerged may be readily distinguished by the circular cap cut from the head end, the plane of which is at right angles to the axis of the cocoon. The edges of the cut are frayed, as is to be expected in view of the manner in which the opening is made. *Tiphia* itself emerges by eating away an irregular and much smaller hole at one side of the anterior end of the cocoon.

Duration of the Stadia. The period covered by the various stages is fairly well fixed except that of the egg and the primary larva. The latter may spend two to three weeks in the soil in its search for the host, followed by a few days feeding before moulting. The second stage covers three to six days and the third and final larval stage approximately nine months within the host cocoon, of which period only five to eight days are required for the completion of feeding. The pupal stage covers slightly less than one month at summer temperatures. Adult life extends over a period of about six weeks for the females, the males probably dying much earlier.

Stages of the Host Attacked. While under normal conditions *Hyperalonia* attacks the mature larva of its host yet several instances were noted where development had taken place upon pupæ, some of which were well advanced. The determin-

ing factor seems to be the degree of fluidity of the body contents, as the developing body wall of the host largely inhibits feeding by the earlier stages.

Other Hosts of Hyperalonia. In addition to parasitizing *Tiphia* (No. 2037), upon which it is most common, *Hyperalonia oenomaus* was also reared in small numbers from several other species of the genus of suitable size, and from the cocoons of *Scolia* and *Campsomeris* as well. It seems most probable that this species is capable of effectively parasitizing any scoliid cocoon of sufficient size, and the relative proportion of each attacked is dependent upon the physical condition of the soil inhabited by the scarabaeid grubs upon which the Scoliid prey and upon the depth at which the cocoons are normally formed. Thus certain species of *Tiphia* are largely immune from attack by *Hyperalonia*, not because of any resistance factors within themselves, but owing to the fact that the host species of grubs to which they are restricted inhabit heavy soil in preference to that of a light or sandy nature. The cocoons of *Scolia* and *Campsomeris* are largely immune from attack by the Bombyliidæ because of the depth to which the host grubs are carried by the female wasps before the eggs are laid.

HOST RELATIONSHIPS OF THE BOMBYLIIDÆ.

A review of the literature, (see Bezzi 3), relative to the hosts of the Bombyliidæ reveals species of this group parasitic upon the five major orders of insects, namely, Coleoptera, Lepidoptera, Diptera, Orthoptera and Hymenoptera. The following is the list, comprising eighteen genera, of which host records are available, and with it is given the various families and genera of the above orders attacked.

BOMBYLIID GENERA	HOSTS
	COLEOPTERA
Sparnopolius	Scarabaeidæ (*Phyllophaga*)
Spogostylum	Cincindelidæ (*Cicindela*)
Villa	Tenebrionidæ (*Podonta*)
	LEPIDOPTERA
Anthrax	Noctuidæ (*Agrotis, Mamestra, Laphygma, Porosagrotis, Plathypena*)
	Tineidæ (*Gelechia*)
Geron	Tortricidæ (*Laspeyresia*)
	Pyralidæ (*Nephopteryx*)
Systropus	Limacodidæ
Villa	Noctuidæ (*Agrotis, Mamestra, Panolis, Dichromea, Taeniocampa*)

	DIPTERA
Anthrax	Tachinidæ (*Masicera, Winthemia, Sturmia*)
Hemipenthes	Tachinidæ (*Ernestia, Masicera, Parasetigena*)
Thyridanthrax	Muscidæ (*Glossina*)
	ORTHOPTERA
Anastoechus	Acrididæ (*Oedopoda, Stauronotus*)
Anthrax	Acrididæ (*Schistocerca*)
Aphoebantus	Acrididæ (*Caloptenus*)
Callostoma	Acrididæ (*Caloptenus*)
Cytherea	Acrididæ (*Dociostaurus*)
Systoechus	Acrididæ (*Oedopoda, Stauronotus*)
Thyridanthrax	Acrididæ (*Stauronotus, Ocherodes, Arcyptera*)
	HYMENOPTERA
Aphoebantus	Scoliidæ (*Tiphia*)
Anthrax	Apidæ (*Anthophora, Chalicodoma, Megachile, Osmia, Podalirius*)
	Vespidæ (*Odynerus*)
	Crabronidæ (*Cemonus*)
	Sphegidæ (*Trypoxylon, Sceliphron*)
	Ichneumonidæ (*Enicospilus*)
Bombylius	Apidæ (*Andrena, Colletes, Halictus*)
Chrysanthrax	Scoliidæ (*Elis*)
Exoprosopa	Scoliidæ (*Tiphia*)
Hemipenthes	Ichneumonidæ (*Ophion, Banchus*)
Hyperalonia	Psammocharidæ (*Pseudagenia*)
	Sphegidæ (*Sceliphron*)
	Scoliidæ (*Campsomeris, Scolia, Tiphia*)
Spogostylum	Apidæ (*Chalicodoma, Megachile, Osmia, Xylocopa*)
	Crabronidæ (*Cemonus, Pelopoeus*)
Toxophora	Vespidæ (*Eumenes, Odynerus, Pelopoeus*)

Of the above lists the new records presented by the writer are those for *Hyperalonia oenomaus* Rond., upon Scolia, *Campsomeria* and *Tiphia*, and of *Aphoebantus* spp., upon *Tiphia* from Shillong, Assam, India.

The parasitism of Coleoptera by the Bombyliidæ is thus far limited to three species, representing as many genera. Shelford (14) in 1913 presented an extended account of *Spogostylum anale* Say as a primary parasite of *Cincindela* larvæ, while Davis (7) lists *Sparnopolius fulvus* Weid., as attacking *Phyllophaga* grubs. This record is based on the finding of a single larva attached to the back of a grub, and the absence of any further reports of the species as parasitic upon Scarabaeidæ would indicate it to be quite rare in this role. The most recent addition to the series attacking Coleoptera is that of *Villa pyaorga* Lw., attacking the larvæ of the Tenebrionid *Podonta nigrita* F. in Russia. It is stated that in some instances a host mortality of fifty per cent is effected by this parasite.

Among the various genera attacking Lepidoptera the most common are *Anthrax*, *Systropus* and *Villa*. *Systropus*, a distinct group the adults of which resemble those of the Conopidæ more than the typical Bombyliidæ, is apparently confined to the family Limacodidæ. *Systropus* sp. is recorded by Kunckel d' Herculais (10) as reared from cocoons of this family in Algeria, while Prof. O. Lugger reports a similar habit for *S. macer* in Minnesota. The writer has reared a species of the genus from the cocoons of an undetermined Limacodid upon cherry in India. *Anthrax* and *Villa* have been frequently listed from Noctuidæ in various parts of the world, and while some doubt has been expressed as to their relations to these hosts yet the data now available indicate them to be primary parasites rather than secondary. *Geron argentifrons* Bru. is recorded by Maxwell Lefroy (11) as parasitizing *Laspeyresia jaculatrix* Meyr. in India, while a species of the same genus is reported upon a Pyralid in Europe.

Representatives of seven genera are on record as parasitic in the egg cases of Acrididæ in various parts of the world. The first rearing was by C. V. Riley (13), who secured *Systoechus oreas* O. S. from the egg cases in the Western United States. The most frequent rearings from these hosts are of this genus and of *Anastoechus* and *Thyridanthrax* in the United States, Russia and Africa.

Among the Diptera Austen and Hegh (1) mention *Thyridanthrax abruptus* Lw. and *T.* (*Villa*) *lloydi* Austin as parasitic in the puparia of the tsetse-fly (*Glossina morsitans* Westw.) in Africa, while Baer (2) records the rearing of *Hemipenthes morio* L. from the Tachinids *Parasetigena* and *Ernestia rudis*, and mentions the observation of Vassiliew regarding *H. morio* and *Anthrax velutina* Mg. as parasites of *Masicera silvatica* Fall., a Tachinid enemy of certain Lepidoptera.

The greater proportion of hosts thus far determined are among the Hymenoptera, primarily the solitary bees and the fossorial wasps. *Bombylius pumilus* Mg. has been studied by Nielson (12), who describes its development as a parasite of *Colletes* larvæ. In the early part of the first stage the *Bombylius* feeds upon the pollen stored in the cell for the use of the host larva, and only later becomes parasitic. This may also be the case with certain of the other species which prey upon this group of bees.

Four genera have thus far been found to be parasitic upon scoliid larvæ in their cocoons in the soil. *Exoprosopa fascipennis* Say, *E. pueblensis* Jaenn. and *Anthrax parvicornis* Coq. are listed by Davis (7) upon *Tiphia* in the United States, while Swezey records *Chrysanthrax* from *Elis* cocoons. Box (4) mentions two species of *Anthrax* upon *Elis* and *Dielis* in Porto Rico. The writer's rearing of two species of *Aphoebantus* from *Tiphia* cocoons in India is the first record of this genus upon a host other than the Acrididæ, and represents a marked departure from the normal habit of the genus.

From the above list it will be seen that certain forms of Bombyliidæ are beneficial, while others are harmful. In the first category may be placed those which attack the tsetse-fly puparia, the lepidopterous cocoons and the egg-cases of the Acrididæ. In the harmful class may be listed those which destroy the puparia of the tachinids parasitic upon Lepidoptera, those attacking the Scoliidæ and Ichneumonidæ and to a certain extent also those upon some of the fossorial wasps.

LITERATURE ON THE BIOLOGY OF THE BOMBYLIIDÆ.

The published data upon the habits and the post-embryonic forms of the Bombyliidæ is rather fragmentary and scattered. The first account of the biology of a bombyliid was that by Dufour (8) in 1858 upon *Bombylius major*. The most extensive accounts at present available are those by Fabre (9) upon *Argyramoeba* (*Anthrax*) *trifasciata* Mg. parasitizing *Chalicodoma muraria*, by Chapman (5) on *Bombylius major* Nielson (12) upon *Bombylius pumilus* Mg. and by Shelford (14) upon *Spogostylum anale* Say.

Oviposition. According to Chapman the females of *Bombylius major* throw their eggs while in flight against the sloping bank in which are situated the nests of *Andrena*. Fabre states that those of *Argyramoeba trifasciata* are deposited upon or near the surface of the mud cell of the host while the female is in flight, the tip of the abdomen being lightly touched to the surface. Shelford records the females of *Spogostylum anale* as depositing the eggs upon the ground a short distance from the entrance of the burrow of *Cicindela*, after having located the burrow while in flight. This may be repeated a number of times at the same point. There is no evidence available at present to support the theory advanced by Davis (7) in the

case of *Exoprosopa*, a parasite in *Tiphia* cocoons in the United States, that the eggs may be laid upon flowers or directly upon the *Tiphia* females, and thus carried direct to the grubs parasitized by this Scoliid.

The egg of only a single species, *Spogostylum anale*, has thus far been described. It is ellipsoidal in form, light brown in color, measures 0.28 × 0.12 mm. and is not adhesive. This, however, is the ovarian egg, and in no case has a normally deposited egg been obtained experimentally or recovered in the field.

The First Larval Stage. The primary larvæ of the following species have been described or figured; *Argyramoeba* (*Anthrax*) *trifasciata* by Fabre, *Bombylius major* by Chapman, and *B. minor* by Nielson. All of these have the heavily chitinized head, a pair of heavy spines ventrally on each thoracic segment and a pair of long setæ at the end of the last abdominal segment, thus corresponding in all respects to that figured herein for *Hyperalonia*. Shelford refers to the first stage of *S. anale* but does not describe or figure it.

Baer (2), in his discussion of the species found attacking Tachinid puparia in Europe, speculates upon the manner in which the larva gains access to the host. Does it enter the Tachinid maggot before the latter leaves the body of the caterpillar, or enter through a minute opening in the puparium, or finally, does it reach the host larva during the short period of time in which the latter is crawling about the ground searching for a place for pupation? He is inclined to favor the last theory, as with these larvæ abundant upon the ground during a host outbreak the possibilities of the *Anthrax* larvæ reaching the host are excellent. In this case, apparently, the *Anthrax* eggs are laid prior to the time of pupation of the tachinid, and after hatching the larvæ must await the maturing of the host.

The above course of events would be logical if the Bombyliid larva develops endoparasitically within the host, but if feeding upon the pupa is external, yet within the puparium, it would be more practicable to penetrate the puparium directly rather than enter the tachinid larva and then later emerge for feeding after the puparium is formed. No direct evidence is yet available to show that any of the larvæ of the Bombyliidæ enter the body of the host, though this would seem to be the case with those species parasitic on noctuid pupæ.

In the various publications dealing with the first-stage larva of the Bombyliidæ comment is usually made regarding its similarity with the triungulin type exemplified by the coleopterous family Meloidæ. This has come about presumably through a consideration of the three pairs of ventral thoracic spines, one on each segment, which assist in locomotion. There is no analogy, however, between these and the legs of the Meloidæ, and the larva may more aptly be termed a planidium rather than a triungulin. In *Hyperalonia* these spines are relatively short and slender and can have little functional significance. The larvæ of the Dexiidæ, which parasitize scarabaeid grubs, burrow about in the soil in search of the host and penetrate it when found, do not possess these thoracic setæ, yet their powers of locomotion are not restricted thereby.

The Second and Third Larval Stages. These two larval stages present no distinctive features, and are practically identical in all of the species which have been described. Shelford states that *S. anale* presumably has four larval stages.

The Pupal Stage. The pupæ of many species have been described and are largely identical in the possession of the heavy pronged "crown" upon the head and the rows of heavy spines and setæ upon the abdominal segments. Specific modifications exist in these characters, though the divergence is not great. The only exception is *Systropus*, the adult of which greatly resembles the Conopidæ, in which the pupa is stated by Kunckel d' Herculais to be quite distinct from that of other Bombyliidæ. Box (4) mentions the frequent finding of pupa cases of *Anthrax* projecting from empty cocoons of *Elis* and *Dielis*, thus differing from *Hyperalonia*, *Spogostylum*, *Aphoebantus* and others, which work their way to the surface of the soil before emerging.

Hibernation. The various members of this family usually pass the winter in the mature larval or pupal stage in the host cocoon or egg-case, the former being the more general. *Agryramoeba trifasciata* has this habit, as does *Bombylius major* (to a certain extent in the pupal stage also), as well as *Hyperalonia oenomaus*, *Exoprosopa* sp., and *Aphoebantus* spp., studied by the writer. *Systropus* in Algeria may prolong its larval stage to three years, according to Kunckel d' Herculais. *Spogostylum anale*, according to Shelford, passes the winter in the second larval stage upon its living host, a habit not recorded for any other member of the family.

DESCRIPTIONS OF THE IMMATURE STAGES OF HYPERALONIA OENOMAUS ROND.

First Stage Larva.—(Fig. 2). Vermiform; length immediately after hatching 0.9 mm., width, 0.1 mm., and grayish white in color. Thirteen segments, the body segments subequal in length. Two pairs of open spiracles, situated on the first thoracic and the last abdominal segments, respectively. The head heavily chitinized, with the anterior margin serrate, and numerous fairly heavy spines.

The thoracic segments each with one pair of long slender spines extending laterally from the ventral margin. The caudal segment with one pair of slender spines about one-third the length of the body, and arising from distinct prominences. Distinct intersegmental "welts" between each pair of abdominal segments at the outer ventral margins.

Second Stage Larva.—(Fig. 3). Thirteen segmented, the constrictions very pronounced; length 2.7—3.5 mm., broadest in the abdominal region (.6 mm.), and diminishing sharply in width cephalad. Two pairs of simple open spiracles. No spines or setæ present. The body color mottled white because of the heavy masses of fatty tissue showing through the transparent derm. The median dorsal line and the intersegmental areas lack these fat bodies and consequently have the yellowish color of the body fluids.

Third Stage Larva.—(Fig. 4). Thirteen segmented, and broadest in the abdominal region. Length, 15-18 mm. Color white with the dark-colored digestive tract visible in some individuals, but mottled in the abdominal regions. Two pairs of open spiracles situated on the posterior margins of the first thoracic and the eighth abdominal segments respectively. The posterior spiracles (Fig. 5) crescent-shaped, 0.08 mm. in length and with about twelve openings. The anterior spiracles similar but more lightly chit nized.

Pupa. Length, 15-20 mm. The head with a "prong crown" (Fig. 6) comprising six heavy prongs, the median pair with a tooth at the base on the outer side, and the ventral pair fused together at the base. Body spines and setæ typical of the family.

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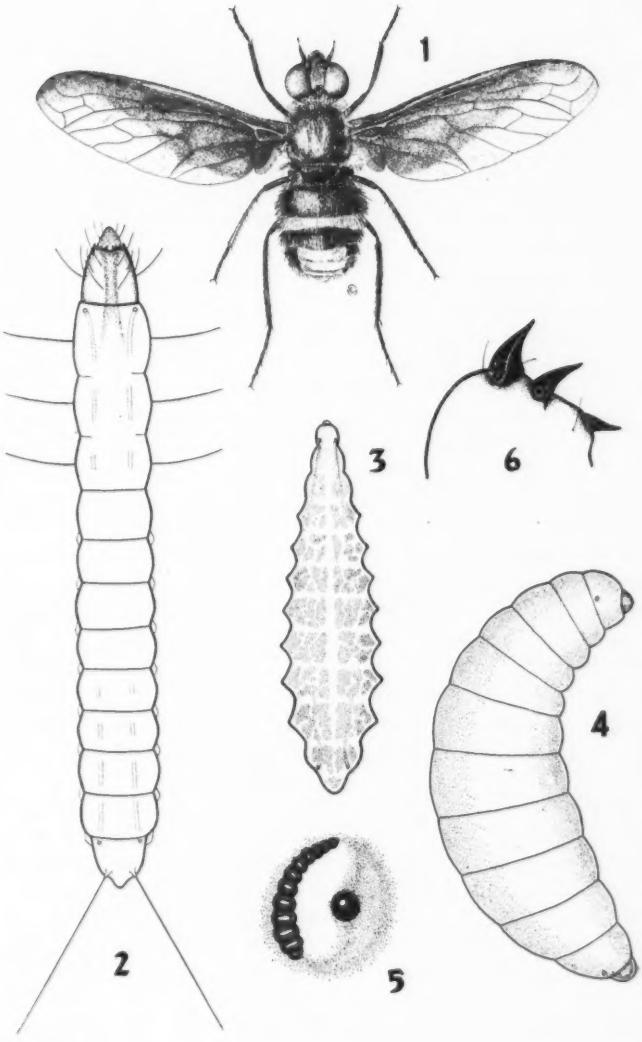
EXPLANATION OF PLATE XXXIII.

Hyperalonia oenomaus Rond.

Fig. 1. Adult female (× 2.5).
Fig. 2. First stage larva (× 88).
Fig. 3. Second stage larva (× 20).
Fig. 4. Third stage larva (× 4).
Fig. 5. Posterior spiracle of third stage larva (× 28).
Fig. 6. Prong crown of pupa.



C. P. Clausen.

NOTES ON THE BIOLOGY OF THE MUSCID FLY, PYRELLIA SERENA MEIGEN, WITH SPECIAL REFERENCE TO ITS HIBERNATION.

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During the course of some field studies on hibernation in the Chicago region,* interest was aroused in the muscid fly, *Pyrellia serena* Meigen,† because of its frequent occurrence in the field and because of its massed method of hibernation. It was thought that this species could possibly be reared in the laboratory and used as experimental material, but unfortunately its life history was unknown. A number of observations were made on its hibernation, and an attempt was made to learn something of the rest of its life history and habits. Although this project was not completed, some data were obtained which seem to be worth recording. These data were obtained chiefly by field observation, but a few experiments were also performed in the laboratory.

The entomological literature is meager on this species. Some descriptive material has been written but little can be found on the habitat and nothing at all on the habits and life history. The species was first described by Meigen (1826) under the name of *Musca serena*. Desvoidy later (1830) established the genus, *Pyrellia*, and the species has since been placed in this genus. Later writers have caused considerable confusion in nomenclature by renaming the species, so that there now exist several synonyms for the species. Hough (1899) and Aldrich (1905) give as synonyms *P. cyanicolor* Zetterstedt and *P. setosa* Loew. Zetterstedt (1845) described *P. serena* and *P. cyanicolor* as separate species but the descriptions tally exactly. Hough (1899) made a careful comparison of his American specimens of *P. cyanicolor* with the European specimens of the same species in the collection of Strobl amd found complete agreement. Zetterstedt gives *P. violacea* Meigen as

* This work was done at the University of Chicago, 1924–1925, under the direction of Dr. W. C. Allee, to whom I am indebted for valuable suggestions.

† Identification by Chas. W. Johnson, of the Boston Society of Natural History.

a variety of *P. cyanicolor*. *Musca occidentis* Walker has been mentioned as a doubtful synonym. It does not seem to the writer that this species could be considered a synonym, for Walker's (1856) description fails to mention the beginnings of the three broad, whitish, longitudinal bands at the anterior end of the thorax, a character which is so prominent that it could scarcely be overlooked by a competent entomologist. The cause of this confusion in nomenclature is due to the fact that the species varies considerably in size (2½-3 lines of the older writers, 4.5-8.0 mm. in the writer's collection), and from the usual steel blue to bright metallic green in color. Aside from these variations, no structural differences were observed by Schiner (1862) and Hough (1899) that would warrant breaking up the species.

Pyrellia serena occurs in both Europe and the United States. It is found sparingly in middle and northern Sweden, and is common at Copenhagen, Denmark (Zetterstedt 1845). *P. violacea*, which has been described as a variety of *P. cyanicolor*, occurs in middle Norway (Zetterstedt 1845). The species has been reported from Stolberg in the Rhineland country of Germany (Meigen 1926), and from Glogau, Germany (Zetterstedt). The species is rare in the Parma district, Italy (Rondani 1862). In the United States, the species has been taken in all the New England states (Johnson 1925), in Pennsylvania (Walton 1911) and, as *P. setosa*, in Illinois. These locality data together with my own which follow indicate a circumboreal distribution.

No definite statement has been found as to the habitat selection. Desvoidy (1830) stated that the genus occurred near water; Schiner (1862) said that the larvæ of the genus may be found in decaying animal material. The most complete statement is that of Zetterstedt (1845) who says that the genus, *Pyrellia*, occurs "in flowers, leaves of plants, cadavers, and dung," and gives the species habitat as that of woods and cultivated areas. Walton (1911), quoting A. B. Champlain, Harrisburg, Pa., pointed out that some of the males and females at least hibernate in rotten logs and stumps.

The flies were first found by the writer on November 17, 1923, at Riverside, Illinois in a flood plain forest along the Des Plaines River. While removing the bark of an old, rotten log in the middle stages of decay, a group of 6 adult specimens

was uncovered. These were all clinging to the sides of a burrow huddled close together. Four of these, at least, were in contact, but were not heaped on top of each other. The same day, groups of 2, 5, 12, 13, and 15 were found as well as a solitary individual, all under bark or in old insect burrows in the interior of logs. These had all begun hibernation in the typical manner and place of over-wintering.

During the remainder of that winter and the following winter of 1924-25, between 300 and 400 hibernating individuals were collected for examination and experiment and many more seen. These were taken from woods in the vicinity of Chicago at the following localities: Palatine, Ill., Palos Park, Ill., Glencoe, Ill., Tremont, Ill., Mineral Springs, Ind., Wilson, Ill., Valparaiso, Ind., and Lakeside, Mich. The woods at these places are of the oak-elm type and rather open. Four male specimens have since (1926) been taken at Northfield, Minnesota from the edge of a thick woods. These were in hibernation. It is true that water is in the vicinity of some of these woods, but the flies were not always found hibernating noticeably close to these bodies of water, as suggested for the genus by Desvoidy.

These hibernating flies always occurred in a very particular type of a log or stump. So numerous were the flies and so specific in their selection of hibernaculum that it was nearly always possible to prophesy whether or not a given log or stump would contain the hibernating flies. *Pyrellia*-containing logs were typically in a medium or late stage of decay, with the usual loose bark and soft, much-burrowed wood. The larger logs with thick bark were more likely to contain the flies than the smaller ones. The wood and bark were always moist, often frozen, and the sides of the burrows and cavities often frost-covered. The flies occupied any cavities in the log which communicated with the exterior either directly under the bark or in some of the old insect burrows in the deeper parts of the log. The wings of the flies usually were covered with numerous tiny droplets of water which had condensed on them.

While a few over-wintered as solitary individuals, the vast majority hibernated in small groups arranged as already described. Some of the individuals were in contact, while others were separated by a small space (1/16-1/2 inch). There was no uniform position of the body in the group except that the individuals were never heaped upon each other as in the

case of ants and bees in winter, but each clung directly to the surface of the burrow or cavity. The size of the group varied from 2 to 38 individuals in each, the usual size being 5 to 7. The group might be composed entirely of males or of females, or might be a mixed group composed of both sexes.

This winter gregariousness was very striking. There were many cavities available in the *Pyrellia* logs, but not all of these cavities were occupied by the hibernating flies, although the environmental conditions seemed to be quite uniform within the log. If the flies were solitary species, one might expect a more even distribution of the flies within the log. Fortunately, several species of *Amblyteles* (Ichneumonidæ) occurred frequently in the same log with *P. serena*. These ichneumon flies are solitary insects and therefore afforded a favorable opportunity for comparison with the gregarious *Pyrellia* flies. Almost without exception, the ichneumon flies were found solitary, each in a separate cavity or old insect burrow, in marked contrast with the *Pyrellia* flies found in groups in the same logs. If mere availability and suitability of hibernation site had been involved, both the ichneumon flies and the *Pyrellia* flies would have been found in groups.

That *P. serena* is definitely a gregarious species in winter was further substantiated by a series of laboratory experiments. The typical hibernation aggregation could easily be produced in the laboratory during the hibernation period. This was done by gradually lowering the temperature to around 5-7° C. Under these conditions, the flies would crawl about for a time and finally come to rest in a group which gradually increased in size until all the flies were assembled in an aggregation of the kind seen in the field. Sudden cooling stupefied them before they could assume the aggregation position, while room temperature prevented the formation of the aggregation. Since the flies were strongly negative to light under conditions of reduced metabolism during the winter, the position of the aggregation could be determined by darkening part of the container. Reduced light is not necessary to bring about aggregation, however, for the flies aggregated normally when fully exposed to light under reduced temperature conditions. Nor is aggregation a mere thigmotropic response, for the flies did not react to bits of broken shell vial that afforded abundant opportunity for contact, nor were any aggregations formed about dead flies in the lab-

oratory. A gradually decreasing temperature, therefore, seems to be the factor which brings about the formation of the aggregation in the laboratory, while light merely determines the position of the aggregation. It is conceivable that the gradually decreasing temperatures of late summer and early fall, especially at night, may be the signal which sends the flies in search for hibernation quarters, and which causes them to gather in the characteristic groups in the logs.

The negativity to light during the winter at low temperatures is in marked contrast with their reaction during the active season. In summer the flies seem to occur in the open well lighted spots in the woods, indicating a strong positive phototropism at this time of the year. When the flies were warmed for a few days, and allowed to fly, they showed a return to positiveness in their light reaction. But when they were quiet, a less definite response to light occurred. This seems to point to a correlation between their rate of metabolism and their reactions. Whether the flies are gregarious in summer was not established.

The flies were never completely dormant in the field during hibernation. If picked up by the wing with a forceps, they buzzed violently in an effort to escape, but usually lacked the ability to fly. When they were then placed in a vial or were put back on the log, they would crawl slowly to cover. Even after warming for several days in the laboratory, their flying was very erratic. They usually flew clumsily toward the window and dropped out of sight in a convenient dark corner.

On several occasions, hibernating specimens were found occupying the same burrow or small cavity with other insect species. On one occasion (Jan. 12, 1924), a fly was found in the same burrow with 6 tenebrionid beetles, *Boletophagus corticola* Say; this fly showed no movements in the field or laboratory, so it is not certain whether it was alive. On February 3, 1924, 3 wood roaches (*Ischnoptera pennsylvanica* De Geer) were found in the same burrow with a live *Pyrellia*. All were placed in the same collecting vial and on the next day, the fly was found with part of its abdomen eaten away by the then lively roaches. Frost is therefore not the only danger that surrounds hibernating animals. Another association with wood roaches was found on March 22. On March 8, 1924, several dead flies were discovered in the same cavity with 6 elaterid

beetles (*Athous reflexus* Lec.). On the same date, 2 dead flies were found, which had shared a burrow with a nabid bug, (*Nabis ferus* Linn). On February 16, 1924, a live fly was found in a cavity only ¼ inch from an unidentified hymenopteran, which was also alive. These are in all likelihood but chance associations, both species being attracted to the same favorable hibernation site. Sometimes these associations are indifferent and sometimes they are hostile.

An attempt was made to breed the flies in the laboratory. This attempt was made with flies captured on the wing in October. They were kept in a screened cage containing various foods and a great variety of possible breeding materials. Such foods as beef broth, solutions of glucose, and diluted condensed milk were fed on absorbent cotton, and placed on the screen at the top of the cage where the flies congregated. In addition, water was given them in the same manner. The flies readily fed on the condensed milk, but were less positive to the glucose. They did not react to the beef broth or to the water. The breeding materials were placed in salve boxes at the bottom of the cage. The following materials in which flies sometimes breed were used: cow dung, horse dung, bird droppings, decaying and fresh meat, fruit, bread, cheese, vegetables, sweets of various kinds, moist and dry soils, decaying leaves and other vegetation. These materials were kept moist (except the dry soil). The flies showed no inclination to breed in these materials. They lived about 40 days after collection and then died without producing any young. The cause of failure of these breeding experiments can only be conjectured. Since the flies had not hibernated, it is possible that they had not recovered from the diapause part of their life cycle (if they undergo diapausic phenomena), and hence had not assumed their normal breeding. Jepson (1909) was able to rear *Musca domestica* in winter (February) using fermenting bread as the breeding material, but this species is often found active in warmed buildings during the winter and may therefore be more readily induced to breed during the winter season.

Some further field observations were made, however, on the life history. A rather thorough search for the adults was begun on July 27, 1924, in the flood-plain forest at Riverside, Illinois, where the flies had been very numerous the preceding winter. The search was continued at this place until September

26 without success, although the flies were subsequently found there in hibernation. On October 11, 13 adult flies were captured on the wing for the first time that season in an oak-elm-hickory association at Palatine, Illinois. These flies looked bright and fresh, as though recently emerged. On October 25, a specimen was seen to crawl out from under a rotten log, having been disturbed by the activity of my hatchet. On November 1, several individuals were observed trying out various burrows in a rotten log, actively searching out hibernation quarters. Each fly seemed to be selecting its hibernation site. They would crawl into a burrow, soon emerge, and then try another, and had I watched the completion of the performance, presumably would have continued searching and investigating the various burrows and cavities until a satisfactory place had been discovered which was reasonably well protected in the deeper parts of the log. The observations on this date were made shortly after noon on a warm sunny day (the temperature at 1:00 P. M. was 23.5° C). There can be no question but that the flies were in search of hibernation quarters on this date. The flies were definitely hibernating on the next field trip (November 8). The preceding year, they were first found in winter quarters on November 17. The entrance into hibernation, therefore, apparently takes place in November.

In 1923, the last date on which the species was found hibernating was April 23, while in 1924, the last date was March 28. The end of hibernation, therefore, comes probably in late March or in April.

No data have been secured as to the rest of the life cycle. While no systematic search was made during spring and summer until late July, the fly was not encountered. And although a vigorous search was instituted from that time on, in a place where the flies had been plentiful the preceding winter, no specimens could be obtained until fall when they were almost ready for hibernation. Other investigators have collected the species in mid-summer. Johnson reported collection from March 26 to October 30 in the New England states, and Zetterstedt (1845) from June 1 to August 14 in Scandinavia. Where the flies spend the summer in the Chicago region is still a mystery.

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ADDITIONS AND CORRECTIONS TO THE MONOGRAPH ON THE PLECOPTERA OF NORTH AMERICA.

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Since the publication in 1925 of the Plecoptera of North America by Dr. J. G. Needham and myself we have discovered several errors in the text, particularly in the keys to species of some of the genera. Inadvertently the list of unrecognizable species of North American forms, which was to be included in the monograph was omitted.

Allocapnia nom. nov.

Type, *Capnella granulata* Clsn.

This name replaces *Capnella* Clsn. (Can. Ent., 56:43,) preoccupied by Gray in Coelenterata 1869. I am indebted to Prof. C. E. Mickel of the University of Minnesota for calling my attention to the homonym.

Taeniopteryx Pict.

The type of this genus is *T. nebulosa* Pict. and not *T. trifasciata* Pict. as stated in the monograph.

Species of Stoneflies not Listed in Plecoptera of North America.

The following is a list of species which we have been unable to recognize on account of inadequate descriptions, loss of type material or inaccessibility to types.

Perla couloni Pict.
P. *naica* Prov.
P. *olivacea* Walk.
P. *picta* Pict.
Isoperla decisa Walk.
I. *decolorata* Walk.
I. *guerinii* Pict.
I. *transmarina* Newm.
Alloperla citrinella Newp.
A. *maculata* Pict.
A. *nana* Walsh—type lost.
A. *severa* Hag.—originally described from a broken specimen of which only the head, part of thorax and one wing are present.
Taeniopteryx glacialis Newp.
T. *chicoutimiensis* Prov.
Nemoura albidipennis Walk.
N. *completa* Walk.
N. *incerta* Prov.
N. *perfecta* Walk.
Leuctra brunnea Prov.
L. *ferruginea* Walk.
L. *tenella* Prov.
Capnia minima Newp.
C. *necydaloides* Pict.

List of Errata.

P. 35. Key to females of Pteronarcys.
In couplet 3 the numbers 4 and 5 should be reversed.
In couplet 5, second part, for "twice as high as broad," read "twice as long as broad."
P. 51. Key to Perlodes. Couplet 4. first part should refer to 6, not 4.
P. 52. Right hand figures in key should be replaced by 7, 8, 9, 10, instead of 6, 7, 8, 9.
P. 107. Key to Alloperla—Couplet 9, first part, "Median carina of supraanal process low," should read, "Median carina of supraanal process prominent."
P. 145. Key to Isoperla—Couplet 3, first part, "pronotum with a basal median yellow stripe," read, "with a broad median yellow stripe."
P. 223. Key to Leuctra—Couplet 4, second part which now ends blindly should lead to *infuscata* Clsn.
P. 237. Key to Taeniopteryx—Couplet 2. In both parts the reference to the costal crossvein should be deleted.

CONCERNING CILIA IN THE ARTHROPODA.

By NATHAN FASTEN,
Department of Zoology, Oregon State Agricultural College.

In a paper in this journal, Vol. XX, No. 3, September 1927, pp. 359-362, by Mr. A. C. Davis of the University of California, entitled "Ciliated Epithelium in the Insecta," there are certain statements made calling into question the published results of Professor Sedgewick on cilia in *Peripatus*, and those of the present writer on ciliated epithelium in the vas deferent ducts of various species of decapod crustacea.

Mr. Davis, in working on the morphology of the orthopteran insect *Stenopelmatus fuscus* Hald., finds a non-vibratile ciliated hem on the epithelial cells in the Malpighian tubules and concludes that "insect anatomists are justified in considering the epithelium of the Malpighian tubules as ciliated until it is definitely proven otherwise."

Then Mr. Davis, apparently applying his knowledge of general invertebrate morphology to the question of the distribution of cilia, assumes that if such structures be found anywhere in these insects they would undoubtedly be most highly developed in the reproductive tubes. With this assumption in mind, he studied living and prepared sections of the oviduct. He found the inner epithelium covered with long, hair-like projections which, at first, he interpreted to be non-vibratile cilia, but later on, after more careful study, he concluded that they were the protruding tail-pieces of spermatozoa, which in wandering up the oviduct, had become enmeshed or embedded in the epithelial cells.

Mr. Davis then asserts: "Sedgewick (1901, pp. 18-19) notes the presence in Neotropical species of *Peripatus* of actively moving cilia in the epithelium of the duct from the receptaculum ovorum to the oviduct, and some zoologists have considered this another argument for excluding the animal from the Arthropoda. Fasten (1917) has demonstrated what he considers to be cilia in the vasa deferentia of several crustaceans. The region of the receptaculum seminis and the vasa deferentia are places in which the condition described above for *Stenopelmatus*

might reasonably be expected to occur, if the epithelial cell-walls are not sufficiently strong to resist the entrance of the spermatozoa, and it is barely possible that Sedgewick and Fasten have encountered this condition in their material and have mistaken it for ciliated epithelium. It would be very easy to err in this, the true condition not being apparent except upon very careful examination, for which there would be no reason if there were not obviously something lacking in the explanation of the presence of cilia, as there is in *Stenopelmatus*.

"In any case, I have thought it well to call attention to the condition as found, that this possible source of error may be guarded against."

As far as Professor Sedgewick's observations are concerned, I wish to state that I am incapable of discussing them because I am not familiar with conditions in *Peripatus*. On the other hand, as far as my own results are concerned, I wish to indicate that Mr. Davis has failed to take into consideration the fact, which ought to be familiar to a student of zoology, that the spermatozoa of the decapod crustacea are of the radial type, with numerous radiating arms that are compactly and tightly coiled around the nuclear portions of the gametes. When these radial spermatozoa are within the vasa deferentia they appear as spheroidal or ellipsoidal structures, organized into a number of packages called spermatophores, and this is the manner in which they are transferred to the female during the process of copulation. The spermatozoa of the insect that Mr. Davis studied are apparently of the flagellate type, a situation which is not found in the decapod crustacea. On what ground, therefore, does Mr. Davis conclude that "it is barely possible that Sedgewick and Fasten have encountered this condition in their material, and have mistaken it for ciliated epithelium?"

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SOME UNDESCRIBED DIASPINES FROM MISSISSIPPI, II.*

(Homoptera: Coccidae)

By GLADYS HOKE,
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Descriptions of two species are presented for publication at this time in anticipation of the use of the names in a forthcoming paper on the Diaspines of the State.

Diaspis dignus, new species.

Scale of Female.—Color white, often tinged with yellow near center; 1.24 to 1.46 mm. long, .9 to 1. mm. broad, thin, slightly convex; exuviæ central or subcentral, first superimposed on anterior half of second, shiny straw color with secretion removed, secretion easily rubbed off; ventral scale a mere film.

Adult Female.—Body mounted on slide .71 to 1.01 mm. long, .56 to .88 mm. broad; derm membranous except small portions of pygidium; antennæ rudimentary, each bearing one to two long curved setæ; anterior spiracerores 5-9, posterior 2-4.

Pygidium.—Lobes in three pairs, median small, bluntly pointed, lateral edges attached along basal half to margins of a shallow median incisura, inner margins strongly divergent, deeply chitinized at base and extending on to pygidium; second pair of lobes completely incised, lobelets small, broadly rounded on distal end; third pair of lobes completely incised, lateral margins of lobelets longest, with or without a notch; median incisura broad; plates arranged 0–1–1–1– 7 to 8; a pair of small setæ between median pair of lobes and a longer one on each lateral margin, four other pairs, one associated with each pair of lobes and two on lateris, dorsal setæ larger, one located mesad of each ventral seta; genacerores 7–12, 11–15, 6–9; altaceratubæ arranged 1–1–2–2–1, opening on protrusions almost as long as lobes, three—rarely two—pairs of ceratubæ as large as altaceratubæ opening near ental ends of second, third, and fourth groups of altacertubæ, eight to eleven pairs of smaller brevaceratubæ usually arranged as in figure; a few small ceratubæ on ventral surface as in figure; anus usually five to six times its own length from distal end of lobes; vulva between anterior and posterior groups of genacerores.

Host.—*Eryngium aquaticum* L. (Button snakeroot).

Locality.—Round Island, on the Gulf Coast of Mississippi; September 30, 1927. Collected by Mr. Troy Thompson.

* Contribution from the Mississippi Agricultural Experiment Station.

Dr. Morrison says, "In many respects your specimens resemble *bromeliæ* but they differ from examples which we consider to be typical of this species in a number of respects, including smaller size and fewer dorsal pores, slighter and more lightly chitinized median lobes, more slender pore and duct between median lobes, etc. At the same time most of the specimens you sent me are evidently parasitized and there remains the possibility that all of these examples may have been modified through the activities of parasites. It seems to me quite possible that more than one species is involved."

Although it is possible that all of the specimens I have examined may have been modified through the activities of parasites, I think that some of them were not and these specimens agree with badly parasitized ones in differing from *bromeliæ* in the characters mentioned by Dr. Morrison, in having the pore-bearing protuberance of each lateris rudimentary instead of long and well developed as in the former, and in other less conspicuous features. These differences seem sufficient to justify regarding it as a distinct species.

The holotype is in the Coccid collection of the Mississippi State Plant Board. Paratypes are in the U. S. National Collection of Coccidæ and in the collection of the author.

Protodiaspis varus, new species.

Scale of Female.—Color white, varying from .5 to 1 mm. long, about one-third as broad; scale thin and fragile, very convex, first exuvia small, pale yellow, at anterior end of scale and of second exuvia, very easily rubbed off, second exuvia large, covered by first exuvia and its attendant secretion, but usually exposed and conspicuous on old scales, second exuvia usually occupying more than one-half the total length of scale, ventral scale practically a continuation of the dorsal with no distinct line of separation, thin beneath body of insect, the portion surrounding the mouth-parts usually remaining attached to the host when the specimen is removed from the plant.

Scale of Male.—About one-half as large as scale of female, exuvia at anterior end, shiny yellow color, scale white, cylindrical, often flattened posteriorly after emergence of male through opening at posterior end, scale loosely constructed, some loose wooly threads often associated with it.

Larva.—Body .198 to .33 mm. long, .099 to .147 mm. broad; derm membranous; antennæ six-segmented, distal segment not annulate; eyes inconspicuous; tentorium about twice as long as broad, rostrum short and broad; coxæ and femora broad, tarsi at least twice as long as tibiæ and broader, claws very slender, digitules long; spiracles small

and slender; margin with a few slender ceratubæ, dorsal surface with five pairs of large ceratubæ, one pair on head, one on each thoracic segment and one on pygidium; pygidium with a small pair of widely separated chitinized lobes, anal setæ almost as long as entire body.

First Exuvia.—Similar to larva, rostrum folded back to within a short distance of ental ends of the large ceratubæ of pygidium; anus near margin.

Second Stage Female.—Body of young specimen .33 mm. long, .147 mm. broad; derm membranous; antennæ rudimentary; tentorium almost as broad as long, rostrum apparently larger in proportion than in larva; spiracles slender, anterior pair apparently with two associated cerores; small ceratubæ more numerous than in larva, many along lateral margin opening through slender plate-like projections, pygidial margin with three pairs of large chitinized ceratubæ, smaller ceratubæ more numerous; margin of pygidium regular, without pectinæ-like projections; anus about in line with the anterior pair of large pygidial ceratubæ.

Second Stage Male.—Similar to female but with about four pairs of short branched plate-like projections of posterior end of pygidium and with the large ceratubæ of the pygidium reduced or sometimes apparently wanting.

Second Exuvia.—Heavily chitinized, segmentation rather distinct, broadest on anterior half, tapering unsymetrically on posterior half, margin with lobes usually indicated.

Adult Female.—Body of specimens examined varying in size and shape, .363 to .528 mm. long, .21 to .36 mm. broad; broadest on anterior half, posterior half usually more or less curved to one side, derm of older specimens more or less chitinized on anterior half; segmentation more or less distinct; antennæ rudimentary, chitinized, each terminating in two or three sharp peaks, and bearing on lateral aspect near base a large curved seta and one or two small ones; tentorium about two-thirds as broad as long; about two to four pores associated with each spiracle; ceratubæ most numerous along marginal area, a row opening onto plate-like projections.

Pygidium.—Lobes in two pairs, short, broad, truncate, distal end apparently serrate, median pair less than the width of one lobe apart, second pair deeply incised, lateral lobelet almost as large as mesal, incisuræ lacking, pectinæ or plates apparently lacking; a dorsal seta associated with each pair of lobes and one on lateris, a ventral seta laterad of each dorsal seta; genacerores lacking; dorsal and ventral surface scattered with ceratubæ, those of the dorsal surface larger, with the opening to the surface frequently surrounded by a light chitinized area; anus large, located near base of pygidium, surrounded by slightly chitinized area; vulva located slightly caudad of anus; apparently ovoviparous.

Host.—Laurel oak (*Quercus laurifolia* Michx. (?); usually on scarred areas or in small cracks or crevices of the bark.

Locality.—1620 Twenty-fourth Avenue, Meridian, Mississippi; June 11, 1928. Collected by Mr. M. L. Grimes.

Although this species secretes a distinct scale while *parvulus* Ckll., the type of the genus, is described as secreting no distinct scale, it is my opinion that the two species are closely related. It differs from Professor Cockerell's description of *parvulus* in having only about two to four cerores associated with the spiracles instead of about eleven, as well as in the possession of a distinct scale by both the male and the female.

The pygidium of the larva and of the adult is very similar to that of *P. lagunæ* Ferris but that of the adult lacks genacerores and apparently lacks the small plates as figured by Ferris for this species.

There is a marked tendency of the males and the females to congregate forming a continuous mass usually with some loose woolly threads associated with the scales. The minute size of the scales makes a careful examination of the host necessary if they are to be seen. This species has been collected from two widely separated areas of the State and on at least two species of oak.

The holotype is in the Coccid collection of the Mississippi State Plant Board. Paratypes are in the same collection and in the collection of the author.

EXPLANATION OF PLATES.

(The drawings were made by Mrs. G. G. DeBord, DeBord Laboratories, Fort Smith, Arkansas).

PLATE XXXIV.

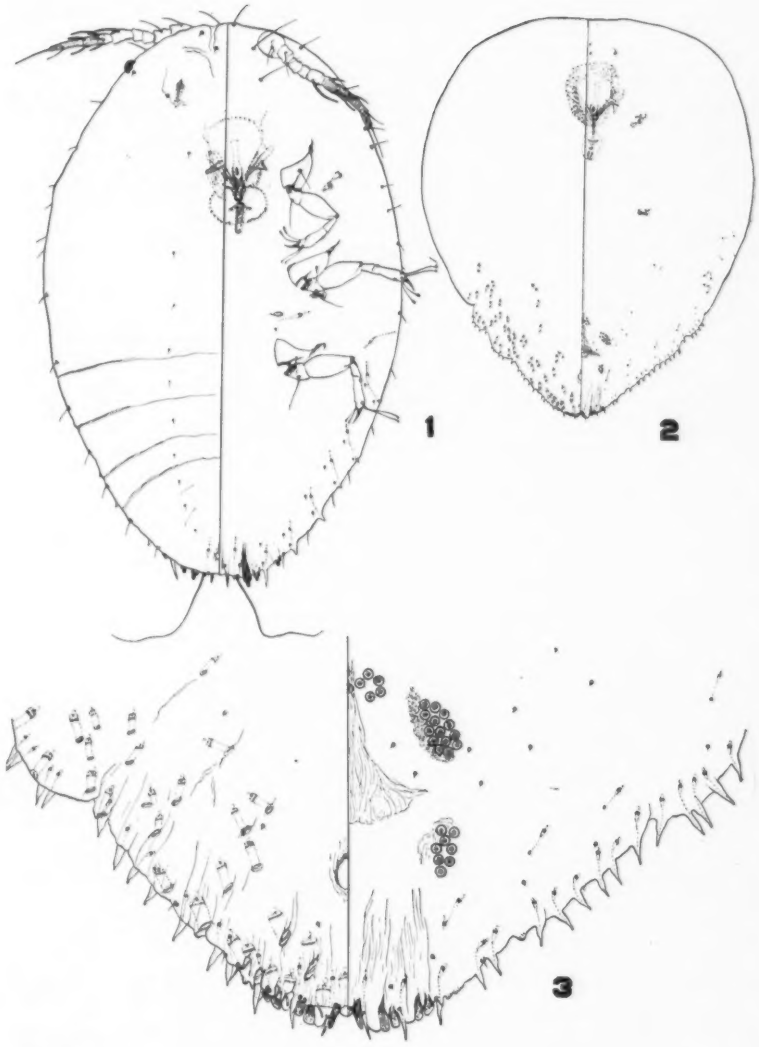
Diaspis dignus, new species.

Fig. 1. Larva, × 290.
Fig. 2. Adult female, × 72.
Fig. 3. Adult female, pygidium, × 290.

PLATE XXXV.

Protodiaspis varus, new species.

Fig. 1. Larva, × 290.
Fig. 2. Larva, dorsal ceratuba near antenna, × 875.
Fig. 3. Larva, dorsal ceratuba near posterior end, × 875.
Fig. 4. Second stage, × 290.
Fig. 5. Adult female, × 152.
Fig. 6. Adult female, pygidium, × 400.
Fig. 7. Adult female, antenna, × 875.
Fig. 8. Adult female, ceratubæ on anterior end, × 875.
Fig. 9. Adult female, spiracerore, × 875.
Fig. 10. Adult female, ceratuba opening through plate-like projection on ventral surface near anterior end, × 875.



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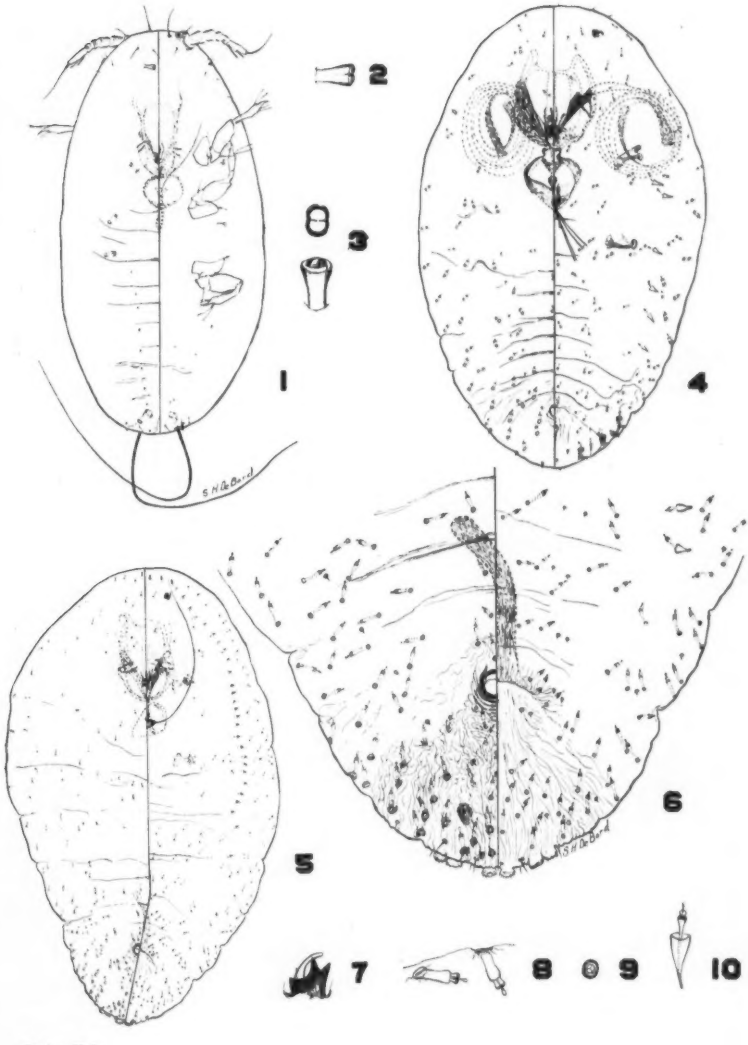

Gladys Hoke

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